Inward Foreign Direct Investment and Intra-Industry Spillovers: The Swiss Case

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Lamia BEN HAMIDA

from Tunisia

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Prof. Dr. Philippe Gugler (First Advisor)
and
Prof. Dr. Laurent Donzé (Second Advisor)

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The Faculty of Economics and Social Sciences at the University of Fribourg neither approves nor disapproves the opinions expressed in a doctoral thesis. They are to be considered those of the author (Decision of the Faculty Council of January 23rd, 1990).

To my parents, my aunts, Wahid, and Mihsen

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Acronyms and Initials

CS	Cross-sectional data
FDI	Foreign Direct Investment
IAs	International acquisitions
IJVs	International joint ventures
GDP	Gross domestic product
KOF	The Swiss institute for business cycle research
MNC	Multinational corporation
MNE	Multinational enterprise
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
SV models	Silverberg and Verspagen models
TFP	Total factor productivity
UNCTAD	Unites Nations Conference on Trade and Development

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Abstract

The attitude towards foreign direct investment (FDI) has changed considerably over the last two decades as many governments around the globe have liberalized their FDI regulations since the early 1980's and are now actively providing generous investment incentives to attract inward FDI (UNCTAD, 2003). The rationale for these policies often stems from the expectation of FDI spillovers (Caves 1974, Cantwell 1991a, Dunning, 1992), which embodies the fact that foreign firms own technological advantages – such as technological know-how, marketing and managerial skills, international experience, and reputation – which can be transmitted to domestic host country' firms, raising their productivity level (Blomström and Kokko, 1998).

Generally, spillovers are said to take place when the entry and presence of MNC's affiliates leads to productivity or efficiency benefits in the domestic firms and the multinational corporations (MNCs) are not able to internalize the full value of these benefits (Blomström and Kokko, 1998). Such spillovers may occur either in the foreign affiliates' own industry or in other industries – among the affiliates suppliers or customers. Intra-industry spillovers may materialize through three main channels. First, there are "demonstration-related spillovers", when the foreign firms after entering the market demonstrate their advanced technologies to domestic firms which may afterwards adapt and imitate them. Second, there are "competition-related spillovers", when the increase in competition that occurs as a result of foreign entry forces domestic firms to introduce new technology and/or work harder. And third, there are "worker mobility-related spillovers", when domestic workers trained by or working in MNCs' affiliates may decide to leave and join an existing or open up a new domestic firm, taking with them some or all of the firm's specific knowledge.

A large amount of literature has developed over the last two decades on the concept of intra-industry spillover effects. Too often, existing studies have merely offered a partial description of these effects, since each of them was concerned with analyzing only one means of the effects. Moreover, they have treated the mechanism by which the technology is transferred as a black box. Our study offers a more complete picture of FDI intra-industry spillovers by distinguishing these effects according to their diverse channels. It hypothesizes that the size and the extent of spillovers depend largely upon the mechanisms by which they occur, since the amount and the nature of the technology diffused differ to a great extent according to the way it is transmitted. In addition, domestic technological characteristics such as domestic absorptive capacity and regional proximity are also taken

into account in our study along with spillover channels, so as to allow for more detailed analysis of spillover effects.

The aim of this thesis is thus to focus in detail on the role of FDI channels as well as domestic absorptive capacity and regional dimension in determining the magnitude and the extent of possible intra-industry spillover benefits from FDI. Unlike existing studies, it calls upon a detailed analysis of these effects according to the mechanisms by which they occur. It argues that the size and the extent of spillover benefits depend largely upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. In addition, geographical proximity between foreign and domestic firms is an important element in determining the size and the extent of spillover effects; spillovers are more likely to occur between neighbors than other more distant firms.

On the basis of these hypotheses, this thesis proposes some components for a research agenda on FDI spillover effects, on both the theoretical and the empirical levels. Relatedly, we develop an evolutionary model of intra-industry spillovers embodying the above hypotheses and we test our theoretical finding against empirical evidence for Switzerland using both qualitative and quantitative analyses – to the best of our knowledge, this study is the first to explore the Swiss case. For the qualitative analysis, we held interviews with managers of foreign and domestic firms of diverse industries from manufacturing and services/construction, operating in Switzerland; while for the quantitative analysis, we made different regression estimations to assess the size and the extent of intra-industry spillovers. Our regression analysis makes use of a thorough measure of domestic absorptive capacity in which the learning and investment efforts of domestic firms come with their existing technological capacities; argument disregarded by most existing empirical studies.

Our simulation and empirical results seem to confirm our hypotheses, in which high and mid technology firms benefit a lot from, respectively, competition and demonstration effects, while low technology firms unable to benefit from foreign affiliates via demonstration effects alone, manage to reap this benefit via the recruitment of MNCs' human capital, in that this channel provides some assistance which can help them to imitate successfully the foreign knowledge. Our results also demonstrate that the geographical dimension matters for intra-industry spillovers. Furthermore, the regression results show that only domestic firms which largely invest in the absorptive capacity benefit from spillovers, resulting mostly from the technology transfer.

Introduction

The multinational corporation (MNC) is an important agent in host countries, in so far as it is able to substantially effect their economic development, since it is largely assumed to be the provider of knowledge, capital, capabilities and markets, the creator of jobs, the supplier of foreign currency, the competition stimulator, etc. (Dunning, 1992, 1993). Most host countries have liberalized their foreign direct investment (FDI) regulations and have been encouraging the inflow of FDI by, for example, providing generous investment and/or tax incentives, enforcing the patent regime, etc.[1] The main motivation for these policies is the assumption of spillover benefits to the host country resulting in productivity growth. The most expected potential benefit is the prospect of acquiring new technology which may spill over to the host country and allow domestic firms to improve their performance (Buckley et al., 2003). This stems from the fact that MNCs are assumed to possess a countervailing advantage over the host country's (domestic) firms (Hymer, 1960, 1968). They use advanced technology (production technology, marketing and management technique, etc.) which makes them more efficient than domestic counterparts (Dunning and Rugman, 1985). Knowledge can be transferred either voluntary through technology transfer agreements or involuntary through spillovers.

Generally, spillovers are said to take place when the entry and the presence of MNC's affiliates lead to efficiency benefits in the host country's domestic firms and the MNCs are not able to internalize the full value of these benefits (Blomström and Kokko,[2] 1998). Intra-industry spillover effects[3] – the focus of this study – are assumed to occur through three channels. First, there are "demonstration effects", when the foreign firms after entering the market demonstrate their advanced technologies; they may afterwards adapt and imitate them. Second, there are "competition effects",when the increase in competition that occurs as a result of foreign entry forces domestic firms to introduce new technology and/or work harder. Third, there are "worker mobility effects", when domestic workers trained by or working in MNCs'

[1]The attitude towards foreign direct investment has considerably changed in the last two decades as many governments around the globe have liberalized their FDI regulations since the early 1980's and are now actively providing generous investment incentives to attract inward FDI (UNCTAD, 2003).

[2]Blomström and Kokko (1998) add that these effects may take place either in the foreign affiliate's own industry or in other industries, among the affiliate's suppliers or customers.

[3]The reasons for studying intra-industry spillovers are detailed in section 3 of the following chapter.

affiliates may decide to leave and join an existing or open up a new domestic firm, taking with them some or all of the MNC-specific knowledge.

1. Intra-industry spillover assessment as a very difficult task

A large literature has developed over the last two decades around the concept of intra-industry spillovers. Despite the policy relevance, spillover effects of FDI on host economies are not well understood. So far, results have been mixed for country studies and evidence on spillovers has not yet been conclusive (chapter 3).

Too often, existing theoretical studies merely offered a partial description of FDI spillovers, since each of them was concerned with analyzing only one means of those effects. For example, in Findlay (1978) and Das (1987) spillovers are determined by the degree of foreign presence alone (contagion-type spillovers). In Wang and Blomström (1992) and Perez (1998) spillovers are rather endogenously generated by the technological competition between foreign affiliates and domestic firms (competition-related spillovers), while in Kaufmann (1997) and Fosfuri et al. (2001) spillovers are the outcome of worker mobility effects. Just as spillovers have not been analyzed at the theoretical level for a complete picture with respect to their diverse channels, so empirical studies have only given partial analyses of these effects. In fact, spillover effects are by and large measured by the share of foreign presence in the corresponding industry. This variable seems to be inappropriate to capture much of the competition and worker mobility-related spillovers; it can only hold the information about demonstration effects. This is one of the reasons why there are contrasts in the scant empirical evidence available.

Thus, the assessment of the existence and the extent of spillover benefits for given firms (industries or countries) calls upon a detailed analysis of these effects according to the ways they occur. As a result, disentangling the effect of demonstration and worker mobility from that of competition by employing technology and competition control variables is required. Such modeling strategy is likely to describe more correctly the process of spilling-over and then identify with accuracy the nature and the size of the resultant effects.

Other possible reasons for the apparently contradictory findings from the country studies are that local characteristics and regional proximity may influence the incidence of spillovers. That is, firstly, it is argued that relatively high technology firms are likely to benefit from spillovers through demonstration and/or competition effects, while small technology firms which are not in a position to compete with foreign firms, may reap benefits from other forms of spillovers such as worker mobility, since this channel provides some personal assistance which can help domestic firms to better understand and implement foreign technology (Mody, 1989). Thereby, only firms with very low technological competence, to a point that they are not capable of reaping profits via any of the spillover channels, enter into a process of cumulative decline and eventually leave the market. Secondly, spillover benefits tend to occur and be more pronounced in locations where domestic firms are

close to their foreign counterparts, so that as geographic distance increases, spillovers decrease (Aitken and Harrison, 1999).

2. The approach in this thesis

This study differs from previous ones with respect to three main points: first, it offers a more comprehensive picture of FDI intra-industry spillovers by distinguishing these effects according to their diverse channels. Second, it hypothesizes that the size and the extent of such spillovers depend upon the interaction between the mechanisms by which they occur and the technology levels of domestic firms. And third, it assumes that spillovers are more likely to occur in neighborhood firms than other more distant ones.

This thesis proposes some components for a research agenda on FDI spillover effects, at both theoretical and empirical levels.

With regards to our theoretical contribution, we develop an evolutionary model of intra-industry spillovers in which we embed the question of spillovers examined in Perez (1998), wherein he explained the process of FDI spillovers by means of a dynamic interaction between foreign and domestic firms at the technological level, into a larger one by allowing for different mechanisms by which domestic firms benefit from FDI. In fact, to protect its market share, a domestic firm may choose to innovate or imitate foreign technologies according to its technological competence. Domestic firms may choose to acquire the best foreign practice technology via either the demonstration mechanism or the recruitment of MNCs' labor.[4] Then, successful learning drives domestic firms to improve their competitive power relative to their foreign counterparts. Such improvement is likely to be higher when foreign and domestic firms are neighbors. Given the complexity of the dynamics defined by the equations of the model, we use simulation techniques to explore its outcome. The simulation results reported in detail in the chapters that follow seem to confirm our hypotheses.

Regarding our empirical contribution, thesis hypotheses are tested against the empirical evidence for the Swiss economy using both qualitative and quantitative analyses of data. To the best of our knowledge, this study is the first to explore the Swiss case. Switzerland is a particularly interesting example for this study given that it experiences increasing flows of inward FDI over time. Switzerland is one of the small European countries which, like Austria and Norway, recorded sharp increases in inward FDI over the last years, mainly in 2003, which even surpassed those of outward investment. It is regarded to have achieved competitive technological levels in many industries such as chemicals, pharmaceuticals, and watches. The Swiss government is more and more active in attracting foreign MNCs.[5] In addition, as argued by Robinson and Schweizer (2006), existing clusters,

[4]MNCs' labor denote the domestic workers who have trained by or worked in MNCs' affiliates.

[5]Favourable tax treatments are provided for many forms of foreign investment (Sermet, 2003).

such as in Biotechnology, financial services, trading, and pharmaceuticals also help define Switzerland as a driving place to do business.

For our qualitative analysis, we interviewed managers of foreign and domestic firms of diverse industries from manufacturing and services/construction, operating in Switzerland. Such firms and industries have been selected according to the industry's and firm's technological capacities, so as to have a heterogeneous firm sample with diverse technology levels. The industry's and firm's technology gaps are used to measure the industry's and firm's technological capacities, derived from innovation activity surveys of manufacturing and services/construction firms, conducted at the Swiss institute for business cycle research "KOF".

While our attention in quantitative analysis focuses on testing the size and the extent of intra-industry spillovers according to the mechanisms by which they occur, the levels of technological capacity of domestic firms – expressed in terms of technology gaps, and the levels of their learning and investment efforts undertaken to absorb foreign knowledge measured by the level of investment expenditures in new equipment and training activities for product/process innovation.[6] The share of total sales in the industry accounted for by foreign firms is used to capture the demonstration-imitation productivity effects and other control variables are used to assess competition and worker mobility-related spillovers. The data for econometric analysis is derived from KOF innovation activity surveys (2002 and 2005) of manufacturing and services/construction firms.[7]

Empirical analyses conducted in the last part of the thesis confirm to a great extent the simulation results; so we conclude that empirical evidence for Switzerland seems to support our hypotheses.

3. The organization of this thesis

Following this introduction, three parts are developed:

Part I: This part consists of three chapters devoted to reviewing and discussing the existing literature of MNCs and spillover effects. In chapter 1, we review the various strands of theoretical thought which explain the existence and growth of MNCs and the main kinds of foreign production they own and control. Then we discuss the resultant effects of MNCs' foreign activities on the competitiveness of the nations receiving them, considering both the direct and the indirect (spillover) effects. Chapters 2 and 3 present, respectively, a survey of existing theoretical and empirical studies of spillovers in the relevant literature and highlight the main shortcomings of existing analyses. The theoretical literature on spillovers, discussed in chapter 2, distinguishes three strands of studies according to the way they occur: spillover benefits that are simply determined by the degree of foreign

[6]Learning and investment efforts of domestic firms are important to come with their existing technological capacities, so as to provide in the approved manner a thorough measure of the domestic absorptive capacity.

[7]We try to bridge the gap by testing spillovers for service/construction industry since there is scarce evidence on this aspect.

presence in the industry – in this way, knowledge is diffused when foreign affiliates come into contact with existing domestic users by way of demonstration. Spillovers are rather endogenously generated by the technological competition between foreign affiliates and domestic firms. And the most recent strand wherein spillovers are assumed to occur mainly from worker mobility. Chapter 3, devoted to analyzing existing empirical studies, takes into consideration the possible explanations of the negative or insignificant results when assessing spillovers. There exist studies dealing with the importance of local and foreign characteristics in determining spillovers. Others explore the question of measurement and linearity of spillover variable, and discuss the role of the regional dimension on spillovers.

Part II: In part 2 our focus shifts to the formulation of an alternative model wherein the precise process of spilling-over is correctly described and then the impact of this process is exactly identified. We develop our theoretical model of spillovers within an evolutionary perspective. Thereby, chapter 4 gives some insights about the basics of evolutionary theory by presenting its main outcomes in the field of economic dynamics, and analyzing the explanatory power of its models and its applicability in the framework of FDI spillover analyses. Chapter 5 discusses in detail the thesis hypotheses and arguments treated in this introduction and presents the equations of our evolutionary model formulated with respect to these hypotheses. To explore the outcome of this model, simulation technique is used in chapter 6 which examines the results obtained by way of computer implementation. It firstly comments on the relationship between spillover effects and the interaction between spillover channels and technology gaps, and then makes explicit the relation between regional proximity and spillovers.

Part III: The third part analyzes the empirical evidence of the model presented in part 2, using data from Switzerland. Thus both qualitative and quantitative analyses are conducted to examine spillover effects in Switzerland. Chapter 7 analyzes data and descriptive statistics about FDI in Switzerland and the performance of domestic firms vis-à-vis their foreign counterparts. It also examines the distribution of those flows both in Switzerland and in the world, the performance of domestic firms vis-à-vis their foreign counterparts, and the contribution of foreign firms to the development of human capital in Switzerland. Chapter 8 summarizes the results from a number of interviews conducted with Swiss and foreign firms. We summarize the methodology adopted for making interviews, and then report the interview results. Finally, the last chapter presents the econometric model embodying the properties of the thesis and discusses the estimation results.

At the end of the parts, we sum up our theoretical and empirical findings and the implications that follow. Thereafter we point out some of the limitations to this thesis and some areas for future research.

Part 1

Multinational Corporations and Spillovers in the Relevant Existing Literature: A Survey

As previously noted, the topics discussed in this study form part of large debate on the effects of the FDI by MNCs, which give particular emphasis to spillover effects in the host countries. FDI is increasingly considered to be the main conduit of new technologies between countries – the creation, diffusion, and commercialization of technological innovations is one of the main characteristics of MNCs (Dunning and Gugler, 1994). It is argued that inward FDI is the principle source of positive spillovers for host (developed and developing) economies (Dunning 1992 and Buckley et al. 2003). Many governments around the globe have liberalized their FDI regulations since the early 1980's and are now actively providing generous investment incentives to attract inward FDI (UNCTAD, 2003). While the expected potential benefits include among others, employment creation, capital formation, export promotion, etc., the main motivation for these policies often stems from the expectation of FDI spillovers resulting in productivity enhancement of domestic firms. In fact, MNCs are assumed to possess a countervailing advantage over the domestic firms in host countries (Hymer, 1960) since they use advanced technology in production, marketing, management, etc. which makes them more efficient than domestic firms (Dunning and Rugman, 1985). Such advanced technology may spill over to domestic firms allowing them to improve their performance. Compared to international trade, the spillover effects derived from FDI to host countries are larger and the importance of the trade channel is much reduced once FDI is controlled (Safarian and Hegazi, 1999).[8]

The earliest discussions of the effects of FDI on the technological development of domestic firms in the literature date back to the early 1960s and emanate from the theory of international production – this theory serves to reveal a better understanding of MNCs' activities. As Cantwell (1989, page 119) said, "*the theory of international production (as set out, for example, in Dunning, 1981, or Caves, 1982) has typically addressed a related set of issues. It has, on the one hand, attempted to answer questions about the geographical location of production by MNCs, the export versus local production decision, and its effect on the industrial structure of national economies (see, for example, Hirsch, 1976; Caves, 1980; and Dunning, ed., 1985) ...*"

Indeed, the attention of the theory of international production has primarily focused on studying the reasons for investing abroad. Diverse thoughts emerged over time and have been concerned with analyzing the determinants of MNCs' behavior. Scholars of international production theory have also discussed the motives for foreign production and the role of MNCs' activities in the economic development of host and home countries – both the direct and the indirect or the spillover effects.

A large literature has developed over the last two decades on the spillover effects of FDI for host countries – with a major concern with intra-industry spillovers – at both the theoretical and the empirical levels. Both the determinants of and the motives for MNCs' foreign production appear to be

[8]Safarian and Hegazi (1999) study spillovers at country level. They do not distinguish between the diverse types of FDI spillovers.

important factors in determining the potential spillover benefits – "*Identifying the variation and dynamics in behavior among firms and across sectors is crucial in understanding how FDI affects the host country*" (Chung et al. 2003, page 215). The literature suggests that spillover effects do not occur automatically but depend largely upon existing characteristics of the investing firms, viz. existing domestic technological strengths, the degree of foreign technology complexity, the motivations for investing abroad, the geographic distance between foreign and domestic firms, etc. Nonetheless, spillover effects of FDI on host economies, as we will see in chapters 2 and 3, are not well understood; results have been mixed for country studies and evidence on spillovers has not been conclusive yet. It is our opinion that a more satisfactory model of spillover effects providing a deeper understanding of the process involved and the channels of knowledge transfer is still required so that the impact of this process can be exactly identified. In this context, our study, as we shall see in parts 2 and 3, offers a more comprehensive picture of FDI intra-industry spillovers at both the theoretical and the empirical levels by distinguishing these effects according to their diverse channels. It hypothesizes that the size and the extent of such spillovers depend largely upon the interaction between the mechanisms by which they occur and the existing technological levels of domestic firms. It also argues that geographical proximity is an important element in determining the size and the extent of spillovers.

The following chapters in this part will concentrate on discussing the existing literature on MNCs as an important agent for spillover benefits for host countries. We shall try to offer a critical account of this literature, attempting to identify its main weaknesses and thereby single out our approach developed in parts 2 and 3. Chapter 1 studies the behaviors of the MNCs by discussing the determinants of their foreign activities, their motives, and their contributions to international technology transfer and the competitiveness of receiving host countries – in line with Chung et al. (2003) we will highlight the importance of MNC's behavior in addressing the question of host country effects, especially spillovers. Chapter 2 discusses in detail the existing theoretical models of intra-industry spillovers and chapter 3 presents the main results of the existing empirical studies on the topic.

CHAPTER 1

Multinational corporations and international production

An MNC is an entity that engages in international production (FDI) by means of its affiliates located in more than one country. It is composed of a mother company located in the home country and a number of foreign affiliates located in several other countries called host countries. By way of international investment, an MNC looks for a diversification of its products. Economic theory recognizes three main forms of diversification and the same MNC may exhibit more than one form. A firm may be horizontally diversified if it produces the same product in several different locations; it may be vertically diversified if it produces intermediate products corresponding to different stages of its same productive sequence; and it is conglomerately diversified if it produces through different productive sequences.

The mother company exercises direct control over the policies of its affiliates and own at least 10% of their assets. The degree of MNC's ownership over its foreign affiliates differs according to the types of FDI or the entry strategy of the MNCs[1]: greenfield investments creating fully-owned affiliates, joint ventures between foreign and host country's firms undertaking economic activity together, and mergers and acquisitions consisting in transfers of existing assets from host country's firms to foreign affiliates. The speed of transferring new technologies from mother company to foreign affiliates is faster for fully-owned affiliates than joint ventures, and in turn the transfer is more rapid when the fully-owned affiliates are located in developed host countries than in developing ones (Mansfield and Romeo, 1980). Also the nature and the amount of technology transferred from mother company to its affiliates differ in terms of ownership structures, in that fully-owned foreign affiliates use newer or more sophisticated technologies than jointly owned investment projects (Javorcik and Spatareanu, 2003). MNCs are reticent to transfer their state-of-the art technology to the affiliates that do not

[1]The strength of competition from domestic rivals is emphasized as a determinant of entry strategy for MNCs (Casson and Buckley, 1998). Tsang's (2005) analysis of the determinants of foreign market entry mode choice in the context of Vietnam indicates that also advertising intensity, country risk of Vietnam, project investment amount, project duration, cultural distance, and location of investment have significant impacts on entry mode choice. Calderón et al. (2002) found that MNCs' entry mode choice (between greenfield FDI and mergers and acquisitions) depends on whether the firm invests in developed or in developing countries. Moreover, Yeheskel et al. (2004) show that the effectiveness of both international joint ventures (IJVs) and international acquisitions (IAs) is consequently related to differentiating successfully between the pre- and post-incorporation stages of these two business forms. A meta-analysis of the determinants of the MNC entry mode choice can be found in Zhao et al. (2004).

have full control over their production, so as to prevent their leakage into the host country (Ethier and Markusen, 1996). Also, the entry of MNCs through greenfield investment increases domestic capacity and intensifies competition (Casson and Buckley, 1998). This is the reason why greenfield investment is viewed as the first target of a host country's promotional efforts since it leads to transferring the newest technologies. Javorick and Spatareanu find that compared to joint venture, only the fully-owned foreign investments seem to be associated with positive productivity spillovers within a sector.[2] Thereby, it is clear that the different types of FDI lead to different amounts and natures of spillover benefits for host countries; this argument will be detailed in chapter 3.

Two distinctive features of an MNC emerge from the definition above: firstly, an MNC organizes and coordinates multiple value-adding activities (production, marketing, R&D, financing, and staffing) beyond national boundaries and secondly, it internalizes the cross-border markets for the intermediate product arising from those activities.[3] Such activities lead to substantial improvement in host country's productivity in terms of spillovers, although in some case studies such as Todo and Miyamoto (2006), intra-industry spillovers for host country's firms in Indonesia are found to be generated by R&D activities of foreign affiliates, but not by their production activities.[4] This finding can not conclude that the production activities of foreign affiliates have no positive spillovers for host countries. In fact, as we shall see in what follows, such spillovers are not automatic but depend on many conditions relative to the foreign and domestic firms (markets and countries).

Although our focus in this thesis is on the spillovers within a sector for host countries, we can not neglect that MNCs' operations abroad also have positive spillover effects on home countries. In line with Blomström and Kokko, (1998), we believe that MNCs that focus on investing in, for example, R&D in foreign industry with leading technologies are very likely to result in the transferring of valuable foreign technology to the home country. The spillover effects from MNCs' activities in R&D stem from the fact that MNCs are increasingly decentralizing their units of R&D by investing abroad (Pearce 1989, Pearce and Papanastassiou, 1999). This helps foreign affiliates gain access to the knowledge of the host country and learn from innovation made by local firms; this knowledge will be transferred back to the investing MNCs' units in the home country, raising their innovation performance and productivity (Lipsey 2002, Griffith et al. 2004, Falzoni and Grasseni 2005, Ambos et al. 2006, and Piscitello and Rabbiosi 2006). Consequently, some of

[2]Policies encouraging foreign MNCs to set up in form of joint ventures may not raise the benefits for the host economy (Meyer et al. 2007).

[3]Dunning (1992) notes that no other institution engages in both cross-border production and transactions.

[4]Many other studies among others (Lichtenberg and van Pottelsberghe de la Potterie 1996, Feinberg and Majumdar 2001, Van Beers and Sadowski 2003, Griffith et al. 2004, and Todo et al. 2006) also found that the R&D activities of foreign affiliates contribute to the improvement of the innovative capacities of host country's firms and then lead to spillover benefits.

the potential benefits for domestic firms in the home country resulting from their interaction with the investing MNCs may be interpreted as spillovers.[5]

Besides the types of FDI and the diverse MNCs' activities undertaken abroad, spillovers within a sector from MNCs to host countries are also influenced by other characteristics, mainly those of the receiving countries – details of those determinants are given in chapters 2 and 3 when outline the main existing theoretical and empirical findings of intra-industry spillovers for host countries. Before introducing those chapters, we will take the time to explain in this chapter why MNCs conduct FDI. The following two sections discuss the determinants and strategic objectives of investing in international production, which in turn affect the nature and the size of spillover effects. Section 3 analyzes the diverse spillover effects benefiting host countries, introduces the kind of spillovers we focus on in this thesis, and reviews in brief the main difficulties encountered in assessing such effects.[6] Finally, the discussion will point to a conclusion.

1. The determinants of multinational corporations' foreign activities

This section analyzes the main key determinants of MNCs' foreign activities – the first concern of the theory of international production[7] – and highlights their importance in addressing the question of how inward FDI affects the host economy,[8] particularly in terms of spillovers.[9] We start with the seminal work of Hymer who advanced the market power approach to analyze the determinants of MNC's activities. He explains the behavior of MNCs by means of market imperfections which still underlie much of the thinking on the determinants of the MNCs' behavior. Moreover, Hymer's approach underlines the importance of MNC's ownership advantage (the best foreign practice technology) that the firm must possess over the domestic firms in the host market to make its international investment viable.[10]

[5]Spillovers for the home country is detailed in studies as Globerman et al. (2000), Popovici (2005), and Bitzer and Görg (2005).

[6]Details of those difficulties as well as proposed solutions are presented in chapters 2 and 3.

[7]It is worth noting that the most explanations of this theory "*are concerned with explaining what firms actually do rather than what they should do*" (Dunning 1992, page 56).

[8]The theory of international production has been extended to embrace the impact of the value adding activities of MNCs on the economic welfare of host country. In this respect, as we demonstrate in chapters 2 and 3 , MNCs intra-industry spillover effects on host countries are not an automatic consequence of foreign entry and presence, but rather they are much often closely related to the domestic and foreign characteristics (such as, the type of FDI, the technological level of foreign firms vis-à-vis their domestic rivals, the technological capacity of domestic firms, etc.). Such effects then vary between countries, sectors, and firms and also over time.

[9]We have to note that the term spillovers in this section and the next one embodies the different kinds of effects, among others the intra-industry spillovers.

[10]This being so, foreign-owned affiliates are generally assumed to be more efficient than domestic firms (Harris, 2002).

Foreign knowledge may thereafter be transferred to domestic firms resulting in spillover benefits.

The theory of MNCs singles out four other streams of thought explaining the existence and growth of MNCs and the foreign activities they own and control.[11] First, we identify the macroeconomic development approach which seeks to explain the location of the MNCs' activities using the theory of international resource allocation based on the spatial distribution of factor endowments and capabilities – it stresses the importance of the countries' comparative advantages in determining the MNCs' location choice and the level of embeddedness of the MNCs' affiliates;[12] this is the primary determinant of the quality of the FDI (Kojima, 1978, 1982 and Dunning, 1988c). The embeddedness of MNCs, as suggested by Marin and Bell (2006), is important in generating spillovers effects to host countries. Narula (2003, page 39) adds that "*it is to be noted that firms build on location advantages that already exist in the host economy (Ritchie 2002), and increases in embeddedness are generally in response to improvements in the domestic technological and absorptive capacity*".

Second, the internalization approach is concerned with the ways in which the cross-border transactions of intermediate products are managed and organized – the costs of organizing cross-border markets in intermediate products is thus considered the main determinant of the existence and growth of MNCs (Buckley and Casson, 1976). Such costs are determined in close connection to the extent of the affiliates' autonomy in shaping their own technological behavior within the structure and strategy of the MNC – the heterogeneity in MNCs' affiliates' technological activities (knowledge-creating or accumulating activities) is regarded as an important source of differences in spillovers (Marin and Bell, 2006). Third, the eclectic paradigm of Dunning (OLI) provides an analytical framework for explaining both the location of the MNCs' activities, and the ownership and organization of these activities. Dunning, along the evolution of his OLI thinking, has also incorporated an evolutionary aspect to this paradigm to be able to consider the dynamics of the MNCs' activities in which MNCs both generate and respond to technological change – identifying the variation and dynamics in behavior among firms and across sectors is crucial to understanding how FDI affects the host economy (Chung et al. 2003). Fourth, the technological accumulation approach considers the existence and growth of MNCs as an evolutionary process subject to, among other things, the effects of their foreign production on both the development of home and host economies and on the embeddedness level of MNCs.

1.1. Market imperfections and ownership advantages. The first contribution to the modern theory of international production was that of Stephen Hymer (1960, 1968), followed by Kindleberger (1973), who in his

[11] Detailed analysis of the theory of MNCs can be found in Cantwell (1991b) and Dunning (1992).

[12] The embeddedness of MNCs is a matter of how long they have been present in host country.

seminal thesis on foreign direct investment and MNCs expresses his dissatisfaction with the theory of market perfections of neoclassical economies to explain the foreign value-added activities of firms. He asserts that in a world of pure competition, where all the products existing in the market are homogeneous and there is the perfect mobility of factors and knowledge of information, direct investment could not exist.[13] Drawing upon the theory of industrial organization (which deals with market imperfections), Hymer's school of thought recognizes that the existence of foreign direct investment is mainly explained by the following: firstly, MNCs must possess a countervailing advantage over the local firms to make such investment viable; secondly, the market of the sale of this advantage (intermediate or/and final product markets) must be imperfect and the outcome of business uncertain (e.g., market structure imperfections, market failure imperfections, market disequilibrium, and government-imposed distortions as trade barriers).

Among the reasons for Hymer's analysis of the determinants of MNCs' activities are that domestic firms have better information on the economic environment in their country than do their foreign affiliates. So MNCs must possess some special ownership advantage – viz. technological know-how, marketing and managerial skills, international experience or reputation – over potential domestic competitors in order to ensure the survival of their affiliates vis-à-vis their domestic counterparts in an imperfect market. Such ownership advantage, as we previously noted, makes the MNCs more efficient than their domestic counterparts. Ownership advantage is more often considered an essential prerequisite for the initial act of foreign production (Kogut, 1983) – it serves, of course, to primarily benefit the competitiveness of the MNC itself, and also, in our view to benefit the host country's firms that expect to learn from it in order to get the necessary strength to face the foreign competition. In addition Hymer states that FDI is an equilibrating force among segmented markets which eventually comes to an end when equilibrium is reestablished across countries; it may be attracted, however, towards areas where the average rates of profits are higher (i.e. when the capital markets are in disequilibrium).

Hymer concludes that direct investments are capital movements associated with the international operations of MNCs. Their goal is to keep control over foreign production, which allows them either to suppress competition or appropriate rents derived from advantages such as cheap raw materials and unskilled labor and/or get access to capital markets, skilled labor, and/ or technology. Hymer asserts that international production has substantially negative effects on the host economies since it raises market

[13]MNCs emerged in the late of the 19th century and continued to grow in the interwar years and after World War II. The increase of direct investment flows was a key factor of the dynamism of Western economies, in particular those from the USA to Western Europe up to around 1960. It is this that justifies the close attention paid by economists to explain those flows and then the birth of the modern theory of international production, advanced by Hymer, as the traditional explanation for this surge were inadequate.

barriers, increases concentration, restricts the ability of governments to control national economy, and may put at risk national productive and innovative systems because MNCs tend to impose their innovative products on the world demand.[14]

Following Hymer's thesis, Kindleberger embeds the question of ownership advantages into a larger one by allowing for the diverse kinds of market imperfections. He investigates the MNCs' behavior according to three imperfections: the final product market imperfections, the intermediate product market imperfections, and the economies of scale and scope.

1.2. Location advantages. While the market power approach relies on the ownership advantages as the main determinant of the MNCs' activities, the macroeconomic development approach, emanating mainly from scholars (such as Vernon, 1966 and Kojima, 1978, 1982), is more concerned with the operation of locational influences on the value adding activities of MNCs. This is not to say that Hymer's theory disregards location advantages but rather that he treats them as exogenous factors related to the MNCs' behavior. It is our opinion that, taken together these two approaches, the international transfer of the technology of the MNC plays an important role in increasing its competitiveness by exploiting the locational advantages offered by diverse production sites. Cantwell and Piscitello (2004, page 6) assert that "*the technological activities of MNCs may tend to agglomerate partly due to a random and cumulative process essentially related to certain natural advantages, but more especially due to the spillovers they can enjoy in the foreign location*".[15]

The macroeconomic development approach draws extensively on the neoclassical theory of the spatial distribution of factor endowments and extends it to embrace intermediate products. It further acknowledges that strategic factors, arising from an oligopolistic market structure wherein MNCs compete fiercely, influence the response of firms to factor endowments. Vernon developed a product cycle model (PCM) serving to explain the technological dynamism associated with the growth of US foreign direct investment in Europe after World War II – in the 1950s and 1960s.[16] He suggests that the determinants of locational strategy of MNCs vary according to the stage of the product cycle the firms are in. The propensity of MNCs to engage in foreign production changes as the product they produce moves from its innovatory to its mature and standard forms. At the initial innovatory phase of product, American firms produced within their national

[14] In this context, as we shall see later, scholars such as Caves (1974), Findlay (1978), and Cantwell (1989) have instead underlined the pro-competitive consequences of MNCs' activities on host economies.

[15] Cantwell and Piscitello (2004) adds that geographic proximity and face-to-face contacts are highly important considerations when developing new technologies since technological development is recognized as a complex, cumulative, tacit, and highly context-specific activity that requires socially organized learning processes.

[16] Vernon's analysis has extended to take account of the potential positive externalities that can emerge from international trade and FDI. It calls upon a debate about policies selection for the economic development of countries.

boundaries and exploited abroad through exports, since the American market offered, among other things, highly skilled labor, abundant capital, high quality infrastructure, and a large demand for innovative products. However, when products became mature they lost their technological advantages and their production was moved abroad, to Europe, where the production factors were cheaper, the transport costs were lower, and the barriers for entry into marketing and distribution were higher. Such process entails the presence of centers of research and development abroad to adapt the mature product to the needs of the domestic market. In this context, Mudambi and Navarra (2004, page 386) add that "*the bargaining power of a subsidiary to maintain and increase its share of the rents generated by the operations of the MNC as a whole is crucially dependent on the nature and pattern of its knowledge flows*". This being so, as we shall see in chapter 3, different technological characteristics of foreign-owned knowledge lead to different amounts and natures of spillover benefits for host economies.

Kojima views the MNC as an instrument by which the comparative trading advantage of nations may be better advanced. In his analysis, he clearly distinguishes between import-substituting investment (trade displacing) and exports (trade-creating) and states that a home country should invest abroad in sectors requiring intermediate (but internationally mobile) products that fit the supply comparatively well, but that need to be combined with nontransferable inputs in which the host country is relatively well endowed.

Before concluding this section, it is important to note that Dunning (1979) also worked out the macroeconomic development theory when he developed the investment development path which mainly deals with the question of FDI growth from the perspective of countries.[17] The basic hypothesis of this path is that a country's propensity to engage in outward or inward investment depends upon 1) its stage of economic development, 2) the structure of its factor endowments and markets, 3) its political and economic systems, and 4) the nature and extent of market failure in the transaction of intermediate products across national boundaries. This investment development path suggests that as a country's economic development proceeds, its foreign investment position will pass through a number of stages.[18]

1.3. Internalization advantages. The third school of thought deals with the internalization approach developed by Casson and Buckely (1976), and draws upon the theory of the firm to explain the existence and growth of MNCs. They suggest that MNC's activity is related to the costs of organizing cross-border markets in intermediate products – the asymmetry of information in the market is identified as the basis of transaction costs. This approach comes from the work of Coase (1937), who recognized transaction cost as a main determinant of the existence and growth of productive organizations. When applied to international production, Casson and Buckely

[17] The investment development path of Dunning was thereafter extended in Dunning (1986) and modified by Tolentino (1987).

[18] A detailed analysis of the investment development path is in Dunning (1988c).

essentially focus on explaining why the cross-border transactions of intermediate products are organized by hierarchies rather than determined by market forces.[19] In this respect, Dunning (2003, page 110) answers of this question by saying that "*the answer was because the transaction costs of the market exceeded those of handling the same transaction within a single entity*". As Meyer (2004) claims, Buckley and Casson's seminal work has mainly stimulated research on how to run business better in terms of profits. In fact, Buckley and Casson address the question of why firms conduct FDI and by doing so, Chung et al. (2003) state that "*they raised critical issues for policymakers. Notably, what stance should host country governments take towards FDI, as FDI causes social and environmental externalities? Buckley and Casson suggested that entering foreign firms might train labor, cause greater worker migration, and exhaust critical inputs. They asked whether the net welfare outcome for the host country is positive*". Thus, we see that Casson and Buckley also raised the question of how MNC's activities affect the host economy.

As explained by Cason and Buckely, the starting point of their theory is that the modern business sector carries out many activities apart from the routine production of goods and services. These activities, including marketing, R&D and training labor, are interdependent and related by flows of intermediate products – mostly in the form of knowledge and expertise. However, intermediate product markets are difficult to organize due to their imperfections; this represents an incentive to bypass them. Four main groups of imperfection factors are found relevant to the internalization decision: firm, industry, region, and nation-specific factors; but Casson and Buckely put the main emphasis on industry specific factors. Then, it results in the creation of internal markets that bring the MNCs' activities under common ownership and control them. Rugman (1980) asserts that MNCs arise due to the internalization of the failure of the market for information. In this context, Casson and Buckley (2003) affirm that it is the internalization of the imperfect market for technology that creates the link between MNC's innovation and multinational production. Of course, the type of technology transferred within the MNC has major implications for its transaction costs and thus its internalization. In that, MNC's strategic objectives to exploit its ownership advantage or to gain access to foreign resources have different implications for its internalization.[20]

Thus, the MNC according to Casson and Buckely is defined as a firm which owns and controls activities in different countries. Their thesis is based on three hypotheses: First, MNCs maximize profit in a world of imperfect markets. Second, when markets in intermediate products are imperfect, there is an incentive to bypass them by creating internal markets; this brings

[19]Transaction costs were not analyzed for the first time in the framework of international production by Buckely and Casson. Hymer had already mentioned them in his dissertation, but they were implicitly investigated – Dunning and Rugman (1985) said in their article, written in honor of Stephen H. Hymer, that Hymer misses the distinction between structural and transaction-cost (cognitive) market imperfections.

[20]We shall see in the next section and in chapter 3 that MNC strategic objectives also affect the size and the signs of FDI spillover effects on host countries.

the different activities of the firm under common ownership and controls them. Third, internalization of markets across national boundaries generates MNCs.

Internalization theory may be considered as a general theory in so far as it is able to predict the situations in which firms choose to internalize foreign markets. However, as argued by Dunning (1992), it is not in itself sufficient to explain the level and structure of the foreign production of firms. The study of MNCs' activities calls for ownership advantages and location-specific variables to be integrated with internalization variables; this provides a unified theory of MNCs in which the eclectic paradigm of Dunning, as we shall see in the following section, fits nicely.

1.4. OLI paradigm. As Dunning (1992, page 68) said, "*it is difficult to perceive an all-embracing theory of the determinants of the MNE's activities in the sense of encompassing, within a single explanatory equation, a set of variables that can fully explain each at the same time as there are four types of value-added activities undertaken by MNEs and they may be differently motivated. The most the economist or business analyst can reasonably do is to formulate paradigms to provide an analytical framework for explaining the various kinds of MNE activity or theories designed to explain particular kinds of FDI*".

Dunning states that the theory of the determinants of MNC's activity must then seek to explain the location of value-adding activities and the ownership and organization of these activities. As such, it needs to draw upon and integrate the three strands of thought discussed above: the theory of international resource allocation based upon the spatial distribution of factor endowments and capabilities, chiefly addresses itself to the location of production; the theory of economic organization is essentially concerned with the ownership of this production; and the internalization theory is related to the costs of organizing and managing cross-border markets in intermediate products of this production. Thus Dunning identifies the ownership, location, and internalization advantages as preconditions for a firm to engage in foreign production.

Drawing upon those assumptions, Dunning (1977, 1981, 1988a,b) develops his eclectic paradigm (OLI paradigm), which seems sufficient to explain the level and structure of the production of a country's own firms outside their national boundaries. This paradigm seeks to offer a general framework for determining the extent and the pattern of MNC's activity and assumes that the level and structure of foreign value adding activities will depend upon:

(i) The extent to which an MNC possesses sustainable ownership specific advantages deriving either from their own specific technologies, their technical and/or managerial skills, or preferential access to particular markets,
(ii) assuming the condition (i) is satisfied, MNC's activities depend on the extent to which it internalizes its cross-border markets,

(iii) And given conditions (i) and (ii), an MNC tends to choose the foreign territory according to the location advantages of host countries.

Appendix 1 summarizes the different components of the OLI paradigm.

Since we know that the presence of MNCs abroad generates benefits for the economic performance of host countries, Dunning's OLI paradigm has been extended to incorporate some additional components called the strategy initiating variables in order that OLI becomes, to some extent, appropriate to explain the dynamics of MNCs' activities and their effects on host economies. To this end, Dunning (1992) enlarged his eclectic paradigm to offer a schema for analyzing the interaction between the consequences of FDI (inward and outward) and the behavior of MNCs, which might apply to all kinds of FDI and embrace all kinds of impacts ("the OLI paradigm revised"). He suggests that the impact of MNC's activity varies according to, firstly, the nature and extent of its ownership advantages, secondly, its propensity to internalize cross-border markets for intermediate products, and thirdly, the location specific characteristics of the host country. He also suggests that OLI characteristics are likely to vary according to the countries and sectors of activity in which foreign firms are located and also according to the characteristics of investing firms. To construct the "OLI paradigm revised", the OLI paradigm is amplified by four supplementary paradigms, viz. the environmental/systems/policy (ESP) paradigm,[21] the Porter's diamond of competitive advantages,[22] the asset accumulation and restructuring paradigm first introduced by Pavitt(1987) and Cantwell (1989), and the stage growth paradigm.[23] Doing so, Dunning examines the dynamics of the MNCs' activities and explains them as follows[24] : "*inbound MNE activity will, over time, affect the L-specific assets of the recipient country. It will do this initially via its impact on the structure and components of its diamond of the competitive advantage and on the actions of the host government. Next, depending on the sectors and countries in which the investment is made and the presence, or absence, of effective competition and supply capabilities, the cumulative assets of the country may be beneficially or adversely affected. This, in turn, will change both the configuration of the ESP of the host country and the OLI configuration facing both foreign and domestic firms*" (Dunning 1992, pages 266-267).

1.5. Technological accumulation. This strand is the more recent one. It deals with some dynamics of MNC's activity and tends to explain the extent to which the internationalization of production is related to the ability of firms to accumulate, integrate, and control ownership advantages across

[21]The ESP paradigm was formulated by Koopman and Montias (1971).

[22]More details of diamond for competitive advantages are in Porter (1990).

[23]This paradigm was advanced by Rostow (1959).

[24]A detailed representation of the Dynamic interplay between MNC activity and the economies in which they operate is given in Exihibit 10.1 of Dunning (1992).

national boundaries. This theory, based on competitive international industry approaches,[25] is called the technological accumulation approach and was first put forward by Pavitt (1987) and mainly developed by Cantwell in his 1989 book, wherein the conditions for technological creation and its effective and efficient use in production are considered as the key factors to determining the MNCs' activities. Respectively, the expansion of MNC is largely linked to a process of technological accumulation within the firm (Pavitt, 1987). Freeman (1980, page3) claims that "*Cantwell's book is a landmark in the study of multinational corporations, both for its critique of some established theories, such as a common version of the product-cycle theory, and even more for its own novel interpretation*". The term technological accumulation as stated by Cantwell (1989, page 7) "*encapsulates the idea that the development of technology within a firm is a cumulative process*". Innovation and the growth of international production in Cantwell's view are mutually supportive.

In contrast to the market power approach in which MNC's activities have anticompetitive effects – they lower the extent of competition and increase collusion among firms, the competitive international industry approaches share the view that the growth of cross-border production tends to be associated with competition strengthening. Cantwell, for example, shares Graham's (1985) view in which the increase of internationalization helps to maintain the competition between MNCs. This interaction between internationalization and competition is explained by the fact that, firstly, MNCs gain access to new and complementary technological developments by locating production abroad and tend to integrate them into their existing technological lines. Competition between MNCs is then enhanced as the overlap between the technological development of firms increases. Also the number of cooperative agreements grows as the number of technological spillovers between firms increases. According to Cantwell (1989, page 13), spillovers " *occur where technologies are created by a firm which lie outside its own major lines of development but which may be of great use within the main traditions of another firm*". Secondly, and partly because of the first element, a growing number of connections emerge between technologies which consequently leads to competition between firms, especially MNCs.

When analyzing the dynamic path of foreign MNCs' activities, in the vein of Dunning, Cantwell discusses the effects of these activities on the development of host economies and afterwards on the embeddedness level of MNCs. In fact, the technological accumulation approach is based on the fact that MNCs are increasingly seen as global organizers of economic systems, including systems relating technological developments in different parts of the world.[26] The involvement of MNCs in research in centers of

[25]Competitive international industry approaches also include, among others, the later versions of the product cycle model and the consideration of oligopolistic interaction theory (Vernon, 1974 and Graham, 1975), wherein the reason for relocating abroad when the product maturated is no longer a matter of a simple firm's profit maximization but shifted towards risk-minimizing strategies.

[26]At one time MNCs were viewed as simply the providers of technology.

innovation has a direct effect on broadening the scope of domestic technological capability, and also an indirect effect (the spillover effect) through its competitive stimulus which encourages other firms to extend their local research programmes. MNCs in a competitive international industry are all attracted to certain centers of innovation in order to maintain their overall strength; as a result research and production tends to agglomerate in these locations. Cantwell asserts that spillover effects are subject to the absorptive capacity of domestic firms – spillover benefits occur only for domestic firms with higher absorptive capacities.[27]

2. The objectives of multinational corporations' foreign activities

In the previous section we examined the key determinants of MNCs' foreign value-added activities in the relevant existing literature wherein the question of how MNC's activities affect the host economy is highlighted. In this respect, economic analysis distinguishes two controversial views concerning the effects of the existence and growth of MNCs' foreign activities: the pro-competitive effects pointing out various kinds of spillover benefits for the domestic economy (e.g. Cantwell 1989 and Dunning 1992) and the possible anti-competitive effects lowering the domestic market power (e.g. Hymer 1970).[28] In this section, the discussion will be extended to explain the behavior of MNCs in terms of strategic objectives of (or motives for) doing international production. We recognize, as we shall see later, four main kinds of the MNCs' motivations which influence in different ways the type and the amount of the technology transferred to host countries and thus the amount and the nature of potential spillover benefits.[29]

MNCs do not pop up randomly in foreign countries. They constantly attempt to increase their profits over time and choose to undertake foreign production in locations where their long-term profitability is expected to be improved. Diverse factors mediate the choice of a foreign location and motivate an MNC to invest: The resource-seeking and market-seeking investment approaches, which were the first motives for foreign investment, and the efficiency-seeking and strategic asset or capability-seeking investment, which came out in 1960.[30] As noted in Narula (2003), the first three kinds of investment can represent motives which are primarily asset exploiting in nature, while the strategic asset-seeking investment represents an asset augmenting activity whereby firms choose to acquire additional assets over

[27] A detailed description of the Cantwell's (1989) analysis of spillovers for host countries is given in chapter 3.

[28] Recently, economic debate has rised, rather than a univocal relationship between FDI and domestic economic development, both virtuous and vicious circles of domestic development resulting from, respectively, positive and negative FDI effects (Cantwell and Dunning 1991 and Perez 1998) – more details on this recent thinking are given in chapter 3.

[29] Case studies analyzing the effects of FDI motives on spillovers for host countries are detailed in chapter 3.

[30] Relating to Vernon's theory explained above, we could say that the PCM tends to explain market seeking production by firms of a particular nationality and ownership – it does not explain resource based, efficiency seeking or strategic assets acquiring investment.

their existing created ones to protect their long-term competitive power. It is argued, as we shall see in chapter 3, that MNC's foreign activities, as a mean of exploiting its existing knowledge abroad, actively contribute to the transfer of new technologies to the host country and then to the expansion of domestic spillover benefits, while MNC's activities as a means of acquiring a host country's knowledge benefits from absorbing technological spillovers from domestic firms.

As identified in the taxonomy used by Behrman (1972) and extended by Dunning (1992), the motives for foreign production are of four types: firstly, a firm is called a resources seeker when it invests abroad to acquire specific resources at a lower real cost than what could be found in their home country. Relatedly, three kinds of resources seekers come out: First, MNCs seek to reduce the cost of their physical resources and acquire minerals, raw materials, agricultural products, constructions, and machines at minimum prices. Second, as labor costs tend to differ between nations, MNCs can hold down costs by locating part of all their productive facilities abroad and getting access to the cheaper labor force there. Third, MNCs tend to locate abroad, particularly in developed countries, when they need to acquire technological capability, qualified labor, management or marketing expertise, and organizational skills. Dunning (1992, page 57) mentions that "*the needs of the first and second kinds have decreased in the mid 1980s but the third type is more important than it used to be*". It also appears that most of the output of affiliates of natural resources seekers is exported.

Secondly, there exist firms that seek to maintain or protect existing markets or to exploit or promote new ones. In most cases, this kind of firms previously exported to these markets but because of tariffs or other cost-raising barriers imposed by host countries, these markets are no longer best supplied by exports. This kind of foreign investment may be a result of attracting policies adopted by many of the host countries. It could also be a part of the global production and marketing strategy of MNCs in order to be present in the leading markets supplied by their competitors. MNCs may choose to be present in the domestic market to supply goods and services than if they were outside the domestic country, because the production and transaction costs are less expensive and also MNCs need to be close to their suppliers or customers to retain their business.

Thirdly, some MNCs seek the efficiency or the rationality which results from the common ownership of their diversified overseas activities so as to be able to maintain and continuously improve their position and competitive power vis-à-vis their rivals in the international markets. Effeciency-seekers take advantage essentially of the economies of scale and scope and from the risk diversification, when they make investments in countries with broadly similar economic structures and income levels. Moreover, given that technology and information intensive value-added activities tend to be concentrated in developed countries and labor and natural resource intensive activities in developing ones, MNCs may benefit from the differences in the availability and the cost of traditional factor endowments by investing at the same time in both developed and developing countries. It is also argued that foreign

affiliates of a more efficiency-seeking nature are likely to be better embedded in the domestic environment (Papanastassiou et al., 2005).

Fourthly, like efficiency seekers, firms which search for strategically related created assets aim, as described by Dunning, to capitalize on the benefits of the common ownership of diversified activities and capabilities, or of similar activities and capabilities in diverse economic and potential environments. The MNC's foreign expansion can be regarded not only as a way to internally exploit its existing ownership advantage on a host market (Hymer 1960, and Casson and Buckley 1976), but also as a way to absorb domestic knowledge and then build new firm-specific advantage (Kuemmerle, 1999). Thus, by investing in knowledge/asset-seeking FDI, the MNC's explicit motive is to gain access to new technologies (e.g. innovative capacities, managerial and organizational knowledge, intangible resources, a better comprehension of the domestic customers) from the host country (Dunning and Narula 1995), raising its productivity. It emerges then that foreign-owned firms benefit from reverse technology spillovers.[31] Kuemmerle (1999, page 18) claims that "*firms seek different types of spillovers from the national and local environment in which they invest. It would be precipitous, however, to assume that foreign firms investing in local R&D facilities are free riders. Foreign firms also create spillovers for the local environment because R&D sites provide employment and learning opportunities for local researchers*".

It is worthwhile to add that the motives for foreign production may also change over time. Initially, most MNCs invest outside their home countries to acquire natural resources or gain access to markets. Later, as their degree of multinationality increases, they change their foreign investment strategy to seek efficiency or strategic assets so as to improve their global market position. Government FDI policies of host countries which are interested in the outcome of the activities of MNCs may also effect the activities of such firms and the amount and pattern of their foreign investment. For example, host countries that attempt to attract FDI are mainly motivated by the expectation of technology transfer or technology spillover effects from MNCs to domestic firms (Ito 2004 and Lim 2005).

Moreover, Dunning identified three further motives for foreign investment, viz. escape investments wherein the MNCs invest abroad to escape restrictive legislation or macro-organizational policies by home governments, support investments that maintain and support the rest of the MNCs' activities, and passive investments which involve passive management and are essentially made by large institutional conglomerates that specialize in the buying and selling of firms and also by small firms and individual investors in real estate.[32]

[31] Detailed analysis of these reverse spillovers can be found in, for example, Driffield and Love (2006) and Sanna-Randaccio and Veugelers (2007).

[32] For a detail of those three additional motives for international investment, see chapitre 3, section 3.3.5 of Dunning (1992).

3. The consequences of multinational corporations' foreign activities

After explaining the reasons for the existence and growth of MNC's activities abroad (sections 1 and 2), we would like, in this section, to give some insights about the diverse effects of those activities on competitiveness, particularly, of the nations receiving the foreign production. The FDI literature distinguishes between the direct and indirect effects of MNC's activity on the economic welfare of the host country. As Dunning (1992, page 263) states: "*the direct effects embrace the role of foreign firms as providers and controllers of resources and capabilities to host countries, and the effects of these ownership advantages on the way in which resources and capabilities are allocated both between and within sectors in an economy. Whereas, the indirect effects are related to the impact of the activities of MNCs and their affiliates on their suppliers, competitors and customers, as well as, more generally on the host economy of which they are part*".

Thus, an MNC is considered an important agent in host countries in so far as it is able to substantially affect – both directly and indirectly – economic development. On the one hand, it is assumed to be the provider of knowledge, capital, capabilities and markets, the creator of jobs, the supplier of foreign currency, the competition stimulator, etc. To sum up, these diverse direct effects of MNCs could be discussed under six main points: FDI is firstly associated with an increase in the technological knowledge of the host countries since MNCs when setting up affiliates in those countries transfer part of their technology. Technology " *embraces all forms of physical assets, knowledge and human learning and capabilities that enable the efficient organization and production of goods and services within a particular ESP configuration or Diamond of competitive advantage*" as defined by Dunning (1992, page 287). Technology transfer becomes easier if the MNCs set up innovatory centers overseas. As Dunning and Gugler (1994) asserted, the transnationalization of research and development is an important phenomenon and some of these international R&D operations are realized via cooperative agreements, joint ventures and strategic alliances.

Secondly, MNCs are generally larger than domestic firms, produce goods using state-of-the-art technology with highly qualified employees and then use more capital. This may raise the local supply and demand expectancies on the market and reduce prices. Thirdly, MNCs may either break down monopolies and stimulate competition or create a more monopolistic industry structure, depending on the strength and response level of their domestic counterparts. The increase in competition would result, as we shall see in the following section, in spillover effects for domestic firms. These effects could be negative or positive depending on the competitive power of domestic firms.[33] Fourthly, MNCs affect human capital development in the host country when they are considered job creators and human capability developers. They demand skilled labor and provide attractive employment

[33]The effect of competition may be positive or negative as competitive pressure either induces domestic firms to be more efficient by assimilating foreign konwledge and mobilizing existing ressources or leads to lower economies of scale.

opportunities (Blomström and Kokko, 2002). Also MNCs support the development of universities and related institutions in several ways and give some training courses to domestic employees, mainly international business managers. Gershenberg (1987) found that MNCs are even more active in training domestic employees than domestic firms. The types of training range from on-the-job training to seminars and more formal schooling to overseas education, perhaps at the parent company, depending on the skills needed (Blomström and Kokko, 2002). Fifthly, foreign ownership always carries a cost, in that MNCs may push for policies that are good for them but not necessarily in the interest of the host country – they may erode its sovereignty. And lastly, the MNCs' behavior may affect the balance of payment of host countries in which both export-oriented and import-substituting FDI should improve it.

On the other hand, MNCs are widely considered the main source for spillover benefits reflected in productivity and/or market improvements of the domestic host country's firms. It is generally argued that the expected spillover benefits from inward foreign direct investment is the main motive of many governments in host countries, both developed and developing, for liberalizing their FDI regulations and encouraging the inflow of FDI (Dunning 1992 and Buckley et al. 2003). In fact, MNCs are by and large assumed to possess the advanced technology (production technology, marketing and management technique, etc.) they tend to exploit in many host countries and, consequently, other firms, particularly the host country's, expect to learn from this technology so as to get the necessary strength to face the foreign competition. Knowledge can be transferred either voluntary through technology transfer arrangements or involuntary through spillovers.

The literature recognizes two groups of spillovers. First, productivity spillovers which take place when the entry and the presence of MNC's affiliates lead to efficiency benefits in the host country's local firms and the MNCs are not able to internalize the full value of these benefits (Blomström and Kokko 1998). In this context, spillovers to domestic firms are said to be positive when the resources required for the adoption of foreign technology or the development of the existing one is small relative to the economic value of the underlying technology (Blomström et al., 1999). Whether foreign investors allow positive spillovers depends on the opportunity costs of sharing the knowledge, and the transaction costs of establishing barriers to knowledge flows (Meyer 2004). Second, market access spillovers which materialize when export oriented MNCs provide knowledge about the product technology and the foreign market conditions for domestic firms to be able to benefit from access to those markets through direct exports. Similar kinds of spillovers may occur from domestic to foreign firms as well (called reverse spillovers), especially when domestic firms are highly competitive and possess the best practice technology.

Productivity spillovers are grouped into knowledge spillovers and competitive disciplinary effects. The competitive effects, or rather the incentives

for competition, operate through either a more efficient use of existing technology and resources or an assimilation of foreign technologies.[34] While, knowledge transfer effects may result from the introduction of new know-how, by among other things, demonstrating new technologies and training workers who later work for local firms. The main examples of knowledge spillovers are: (i) new technology transferred to domestic producers who learn new techniques from foreign firms by demonstration effects (also called contagion or imitation effects); (ii) learning by doing among domestic firms, combined with investments in formal education and on-the-job training of domestic employees who move from foreign to domestic firms; (iii) cost savings due to technology passed to downstream users of new products or upstream buyers or suppliers.

In this thesis, we focus on studying in detail the productivity spillover effects from MNCs' affiliates to domestic firms in the same industry (i.e. the intra-industry spillovers); we do not take into account the other kinds of spillover effects, although they are also of a great importance and worthy to be explored and is sometimes hard not to take them into consideration. Our motivation emanates from the fact that (i) the literature has been largely concerned with analysis of intra-industry spillovers and despite the huge amount of existing theoretical and empirical studies, and the relevant policy which encourages the inflows of FDI, intra-industry spillover effects on host countries are still not well understood. So far, results have been mixed for country studies and evidence on this kind of spillover has not been conclusive yet. Therefore, we think that additional studies and further investigations are still required to explain these controversial results and find solutions in order to make clear the positive effects of intra-industry spillovers. And (ii) we believe that each kind of spillover, although they are somehow jointly related, requires a highly context-specific, in-depth exploration. For example, assessing productivity spillovers calls upon a detailed analysis of diverse factors which are not necessary the same as those of market access spillovers.

Although, the term spillovers in the previous two sections of this chapter does not distinguish between the different kinds of spillovers for the host country, in what follows, this term will consistently reflect the intra-industry effects, otherwise it will be specified.

As we have said, lots of case studies have shown that locals learn from MNCs.[35] Most of them demonstrate that spillovers are not automatic consequences of FDI, in that effects are determined by the local environment, e.g., technological capability and labor skills, level of competition, motives for foreign production, trade policy, and regional proximity.[36] However, as we shall see in the following two chapters, too often these studies overlook the fact that the effects of spillovers are not the same according to the diverse channels by which they occur. In fact, (i) they do not consider that

[34]Noting that in short run the competition effects could be of a negative sign (market stealing effects).

[35]Meta-analysis of spillover studies can be found in Blomström and Kokko (1998), Görg and strobel (2001), and Meyer and Sinani (2005).

[36]We analyze and discuss in the next two chapters the main outcome of existing theoretical and empirical literature related to intra-industry spillover effects

the amount and the nature of the technologies transferred from foreign to domestic firms are highly likely to depend upon the mechanism by which they are transmitted. Thereby, spillovers via worker mobility for example are likely to be higher than through demonstration effects, since worker mobility can lead to substantial improvements in productivity throughout the local economy by transferring not only public technology, but also tacit elements (firm-specific knowledge). Also (ii) they use by and large the share of foreign presence in the corresponding industry to measure intra-industry spillovers. However, this variable seems to be inappropriate to capture much of the competition (Kokko, 1996) and worker mobility-related spillovers (Ben Hamida, 2006a) ; it can only hold information about demonstration effects.

Our present study offers a more comprehensive picture of FDI intra-industry spillovers by distinguishing these effects according to their diverse channels. It also highlights the fact the relationship between spillovers and domestic technological characteristics is not unidirectional, rather the size and the extent of such spillovers depend upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. It also assumes that spillovers are more likely to occur between neighboring firms than between more distant ones. This thesis proposes some components for a research agenda on FDI intra-industry spillover effects, at both the theoretical and the empirical levels.[37]

4. Conclusions

In this chapter we have presented what MNCs are, why they conduct FDI, and how they effect the investing and the receiving FDI countries. We distinguish diverse key determinants explaining the existence and growth of the MNCs' foreign production: the ownership advantages, the internalization, the location advantages, the OLI paradigm, and the technological accumulation. Moreover, we identify four main motives for foreign production – resource-seeking, market-seeking, efficiency-seeking and strategic asset-seeking investment approaches. All of these determinants and motivations are found to be highly important when attention is drawn to the impact of MNCs' foreign production. In particular, to engage in international investment, a firm must possess a countervailing technological advantage over domestic firms, so as to make such investment viable. By exploiting this advantage abroad, some of the foreign knowledge is expected to spread throughout foreign locations and then be diffused to domestic firms. Knowledge can be transferred either voluntarily through technology transfer arrangements or involuntarily through spillovers. The transfer of technology is primarily assumed to benefit the competitiveness of the MNC itself by exploiting the locational advantages offered by diverse production sites. However, this benefit is not only felt internally by MNCs. Rather, both the nations of origin and those receiving the MNCs' benefit. Such improvements, especially those related to the host economy are of great importance in determining the embeddedness level of foreign MNCs.

[37] See parts 2 and 3, respectively.

4. Conclusions

As we shall see in chapters 2 and 3, a large body of literature has analyzed the intra-industry spillovers from foreign to domestic firms within the industry – the focus of this study – but too often they pay no attention to the fact that these spillovers tend to vary according to the channels by which they occur, i.e. demonstration effects, competition effects, and worker mobility. These studies use by and large the share of total output, employment, or capital in the industry accounted for by foreign firms as proxy for spillovers. It emerges then that the most reliable evidence points to no or negative spillovers.

Unlike existing studies, this thesis calls upon a detailed analysis of these effects according to how they occur, so as to be able to assess intra-industry spillovers. It also suggests that the size and the extent of spillovers depend largely upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. Spillover benefits are likely to be more pronounced in locations where domestic firms are close to foreign firms.

A detailed description of our thinking about the determination of intra-industry spillover effects is given in parts 2 and 3. But, before proceeding, we discuss in chapters 2 and 3 the main outcomes of existing theoretical and empirical literature related to such effects.

CHAPTER 2

Existing theoretical models of intra-industry spillovers

The earliest discussions of spillover effects in the theoretical literature on FDI date back to the early 1960s. McDougall (1960) was the first author to systematically include productivity spillovers among the possible effects of FDI. Other earlier contributions were provided by Corden (1967) and Cave (1971). The common aim of these studies was to identify the various costs and benefits of FDI, and spillovers (intra- and inter-industrial effects) were discussed together with several other effects such as balance of payments, terms of trade, tax policies, etc. The detailed theoretical models analyzing spillovers did not appear until the late 1970s.

Blomström et al. (1999) have elaborated a theoretical framework for understanding the underlying "supply" and "demand" forces determining the scope and magnitude of FDI spillovers to host economies.[1] They consider spillovers (whatever they are) in a traditional technology market supply and demand context, wherein foreign and domestic investors represent the supply and demand sides, respectively. Spillovers are then endogenously determined by the actions of those investors. The identification and (if possible) quantification of factors on both sides of the "market for spillovers" are important to policy-makers in leveraging the potential benefits of inward FDI spillovers. Table 2.1 summarizes the main proximate variables theoretically related to FDI spillovers and their likely effects. Obviously, we are in agreement that all of these variables[2] are important in determining the scope of FDI spillovers, although some of them are not yet explored in the literature.[3]

In the next three sections of this chapter, we present and discuss the main existing theoretical studies explicitly modeling spillover effects from FDI.[4] We recognize three strands of studies. The earliest ones reported in the following section represent spillovers as an increasing function of the

[1] A comparable framework was previously suggested (at least implicitly) by Cantwell (1991a).

[2] We have to note that other variables such as the geographic proximity between foreign and domestic firms should also be considered when determining FDI spillovers. Recently, Ben Hamida (2006c) has constructed a theoretical model wherein this variable appears among the determinants of spillovers. Geographical proximity is found to have a significant impact on spillovers. These theoretical findings seem to be confirmed for the Swiss case.

[3] It is important to note that empirically, the measurement of some of these variables is considered difficult.

[4] A description of theoretical studies on spillovers is given in Fan (2002).

Determinants	Sign
1) Technological complementarities between MNCs and host country firms	(+)
2) Strength of intellectual property protection in host country	(-)
3) Competition in host country markets	(?)
4) Size and wealth of host country	(+)
5) Technical centers of excellence in host country	(+)
6) Technical competence of host country firms	(+)
7) Government policies	(?)
Note: (+) and (-) indicate, respectively, positive and negative potential effects of the corresponding determinant on spillovers. (?) indicates that these effects could be positive or negative.	

TABLE 2.1. Proximate determinants of spillovers. Source: Blomström et al. (1999), page 7.

presence of foreign capital. Most of those studies consider the superior technology possessed by foreign firms to be intrinsically a "public good" which are transferred without cost to domestic firms. The second strand of models described in section 2 suggest that spillover benefits are costly and can not be determined by the degree of foreign presence alone. Instead, spillovers are largely the outcome of the interaction between foreign and local firms. Section 3 presents the more recent strand of theoretical models in which spillovers occur through the movement of domestic workers previously trained or having worked at MNC's affiliates to domestic firms, taking with them some of the foreign knowledge which can improve their efficiency.

1. Spillovers and the degree of foreign presence

To our knowledge, Kopecky and Koizumi (1977) were the first to explicitly model the technological spillovers generated by the presence of affiliates of foreign MNCs. Particularly, they analyze the role of technological transfers in an international capital movement model and assume that these transfers depend on the extent of foreign ownership of a country's capital stock. According to them, the transmission of foreign technology from foreigners to locals is "automatic" and technology spillovers are therefore treated as public goods which can be exploited free of charge by domestic firms. MNCs are unable to internalize the total returns on them.

Since technology transfer among countries is proxied by the country's capital stock owned by foreign affiliates "K_f", the aggregate production function of resident firms (i.e. domestic and foreign firms) can be written as

$$Y = \Psi\left(\frac{K_f}{L}\right) G\left(K_f + K_d, L\right), \tag{1.1}$$

where Y denotes output by all the firms in the country, L is labor, K_d the stock of capital owned by domestic firms and $\Psi\left(\frac{K_f}{L}\right)$ the technological transfer function. It is assumed that host countries (especially debtors)

always experience technological improvements from their contacts with foreigners so that $\Psi\left(\frac{K_f}{L}\right)$ is greater than one for any $\left(\frac{K_f}{L}\right) > 0$. It is further assumed that the technological benefits received by host countries are proportional to the amount of capital controlled and operated by foreigners, so that $\Psi'\left(\frac{K_f}{L}\right) > 0$.

Kopecky and Koizumi's specification above implies that the marginal products of foreign and domestic capital are different

$$\frac{\partial Y}{\partial K_d} = \Psi G_k, \tag{1.2}$$

$$\frac{\partial Y}{\partial K_f} = \left(\frac{\partial \Psi}{\partial K_f}\right) G + \Psi G_k. \tag{1.3}$$

The term $\left(\frac{\partial \Psi}{\partial K_f}\right) G$ represents the spillover effects produced by the transmission and dissemination of foreign technical know-how within the host country. Because of the "public good" nature of technology, foreigners cannot capture $\left(\frac{\partial Y}{\partial K_f}\right) G$ in the form of a direct monetary payment so that the private marginal products of foreign and domestic capital are the same, ΨG_k.

Findlay (1978) constructs a dynamic model to examine the relationship between FDI from an advanced region and technological change in a backward one. He postulates that the rate of technological progress in the advanced region increases at a constant rate and that in the backward country it depends on two factors. First, the rate of technological progress in a "backward" region is an increasing function of the technology gap between that region and the "advanced" one – a hypothesis advanced by Gerschenkron (1962) and Veblen (1915). Therefore, for a given amount of foreign presence, the larger the technology gap between the foreign and domestic firms, the larger the spillovers.[5] Second, Findlay followed Arrow (1971) in considering technological diffusion as analogous to the spread of a contagious disease. The basis of this analogy is the fact that technological innovations are most efficiently diffused when there is personal contact between those having the knowledge and those who adopt it. Findlay further hypothesizes that the rate of change of technical efficiency in the backward region is an increasing function of the degree to which it opens up to FDI (Mansfield, 1961, 1968) – this hypothesis fits well with the contagion idea.

In more formal terms, $A(t)$ and $B(t)$ denote respectively the levels of technical efficiency in terms of the total productivity of the factors in the advanced and the backward regions. Assuming that $A(t)$ increases at a constant rate n, one has

$$A(t) = A_0 e^{nt}. \tag{1.4}$$

[5]More and more evidence, however, shows that the assumption that technology transfers increase with a larger technology gap is not true (e.g. Cantwell, 1989). This, in our view, seems more reasonable as domestic firms can not internalize technologies in their production process unless they have some traditional technological strength.

Moreover, the Veblen-Gerschenkron's hypothesis can be stated as

$$\dot{B} = \frac{\partial B}{\partial t} = \lambda \left[A_0 e^{nt} - B(t) \right], \tag{1.5}$$

where a dot over a variable indicates its time derivative and λ is a positive constant which indicates the magnitude which depends upon exogenous parameters such as the quality of management of the relatively more backward country and the education of the labor force. Equation (1.5) states that the convergence-type spillover is an increasing function of the technology gap between backward and advanced countries. The differential equation (1.5) is readily integrated to yield

$$B(t) = \frac{\lambda}{(n+\lambda)} A_0 e^{nt} + \frac{(n+\lambda) B_0 - \lambda A_0}{(n+\lambda)} e^{-\lambda t}, \tag{1.6}$$

where B_0 is the initial level of efficiency in the backward region. As t tends to infinity, equation (1.6) shows that the the ratio $B(t)$ to $A(t)$ will approach an "equilibrium gap" of $\frac{\lambda}{(n+\lambda)}$. This equilibrium varies directly with λ and inversely with n.

Using GAP $(= \frac{B(t)}{A(t)})$ to denote the technology gap between domestic firms and MNCs, and FP to be the degree of penetration by the former into the host economy (measured by the the ratio of the capital stock of foreign-owned firms in the backward economy to the capital stock of the domestically-owned firms), the advantages of backwardness (convergence) and contagion hypotheses can be represented as follows

$$\frac{\dot{B}}{B} = f(GAP, FP), \text{ with } \frac{\partial f}{\partial GAP} < 0 \text{ and } \frac{\partial f}{\partial FP} > 0. \tag{1.7}$$

The relative rate of growth of technology gap is itself a function of

$$\frac{G\dot{A}P}{GAP} = g(GAP, FP), \text{ with } \frac{\partial g}{\partial GAP} > 0 \text{ and } \frac{\partial g}{\partial FP} > 0, \tag{1.8}$$

which shows that the catching-up level by local firms is higher the wider the technology gap and the greater the foreign presence.

In his paper, Das (1987) utilizes a standard price-leadership model from oligopoly theory to describe the technology transfer processes, from the parent MNC's firm to its affiliates and in turn from the foreign affiliate to domestic firms. He assumes that the foreign subsidiary acts as a price leader in the domestic market and the local firms constitute a competitive fringe around it. The model explicitly explores the optimal behavior of a multinational firm's subsidiary in a host country when its local rivals succeed in learning its production techniques. Similarly to Kopecky and Koizumi (1977) and Findlay (1978), Das assumes that the rate of increase in efficiency of local firms is positively related to the level of activity of the MNC's subsidiary – the larger the scale of foreign operation the greater the opportunity of the local firms to learn from it. The model recognizes that the MNC's affiliates are aware of the technology leakage, and determines the technology transfer

behavior based on this recognition. Yet, the behavior of the local firm is still not explicitly taken into consideration in any calculations. Das concludes that it is worthwhile for foreign affiliates to import better technology from its parent company to be able to boost its profit levels and its market share, although it loses a lot due to the success of local firms in learning. It emerges then that the greater the amount of technology imported by foreign affiliates from the parent company, the higher the spillovers will be.

Recently, Smeets (2006) states that the relationship between the degree of foreign presence and spillover effects depends on the type of foreign ownership. He builds a partial-equilibrium model wherein he recognizes three different types of ownership (minority, equally, and majority) and finds a non-linear relationship between these types and spillovers. Spillovers are relatively high for equally shared international joint ventures and lower in both minority and majority types of FDI. This result is mainly explained by the fact that the nature and the number of the channels of knowledge spillovers differ per type of FDI ownership[6] – all of these channels are assumed to function in equally shared types but not in others.

While the models described above explore the direct relationship between FDI and technology transfer, another strand of models investigate instead the effect of FDI on growth using growth theory framework. Those models, particularly based on the "endogenous growth theory", indirectly touch upon the role of FDI in transferring technology. Unlike earlier neoclassical modeling of the Solow (1956, 1957) type – which treats technological progress as an exogenous process and suggests that FDI cannot affect the long-run growth rate – endogenous growth theory models technological progress endogenously and emphasizes the role of R&D, human capital accumulation, and spillovers in determining long-run economic growth (Grossman and Helpman 1991, Lucas 1988, Romer 1990).

We recognize mainly two models of the 'new growth theory' with endogenous technological progress that examine the interaction between growth and FDI. First, Wang (1990) builds a dynamic two-country model to study the interactions among growth, technological change and international capital movements. He extends the earlier theoretical models of long-run international capital movements, such as MacDougall's (1960), Kemp's (1961), and Ruffin's (1979) by adding to the Cobb-Douglas production function a country-specific variable labeled human capital which gives a measure of the stock of technical knowledge. Human capital is viewed as the motor of technological change. This model assumes a perfect capital mobility linking the two countries. Human capital has an important role in determining the effective rate of return on physical capital and hence influences the direction and the magnitude of international capital movement. The analysis incorporates Findlay's hypotheses on the contagion and the advantages of backwardness in that the rate of technological change in a less developed country (LDC)

[6]Although Smeets's analysis does not formally model the spillover channels as determinants of spillovers, it recognizes implicity their role through their relationship with the types of MNC ownership. Smeets does not distinguish between intra- and inter-industrial spillovers. Also, he examines the spillover effects from and to the MNC.

increases with the technological disparity between them and the advanced country (the North) and the amount of foreign capital operating in their territory (the South). With capital already moving internationally, the model predicts that the steady-state income gap is narrowed by an increase in the growth rate of human capital and /or the technology diffusion rate in the LDC. Then, opening for FDI from more advanced countries has beneficial effects on developing economies. Foreign investment facilitates domestic technological change via technology spillovers, and hence increases the rate of income growth.

In more formal terms, the per labor output of the home (North "N") and host (South "S") countries are

$$\frac{Y_S}{L_S} = \omega(h_S) f[\frac{K_S}{L_S} + \frac{Z}{L_N}] - \frac{rZ}{L_N}, \tag{1.9}$$

$$\frac{Y_N}{L_N} = \omega(h_N) f[\frac{K_N}{L_N} - \frac{Z}{L_N}] + \frac{rZ}{L_N}, \tag{1.10}$$

where $\omega(h_i) = h_i^{1-\beta}$, $i = S, N$, is the contribution of human capital (h_i) to production which can be interpreted as an index of the technology level of an economy, K is the stock of physical capital, L the stock of labor, Z the amount of foreign capital located in the home country, and r the rate of return of capital in the world.

The accumulation functions of human capital of the South and the North are expressed as

$$\dot{h}_S = \mu_S \theta(x, q) h_S, \text{ with } \frac{\partial \theta}{\partial x} > 0 \text{ and } \frac{\partial \theta}{\partial q} > 0, \tag{1.11}$$

$$\dot{h}_N = \mu_N h_N, \text{ with } \mu_N > \mu_S, \tag{1.12}$$

where μ_S and μ_N denote the growth rates of Southern and Northern human capitals, respectively, x denotes the degree to which the host country is open to FDI and is measured by the ratio of foreign investment to domestically owned capital, and q is the technology gap between host and home countries. The growth rate μ_S can also be interpreted as the technological diffusion rate or technology adaptive efficiency in the South.

The technical knowledge of the host country ($\dot{h}_S$) increases with x and q. Thus, equations (1.11) and (1.12) show that the catching-up level by local firms is higher the wider the technology gap and the greater the foreign presence. The presence of foreign firms then generates positive technology spillovers to the LDC firms and hence increases the rate of income growth.

Second, Walz (1997) constructs a dynamic general equilibrium model with endogenous technological change in which MNCs play a critical role with respect to growth and specialization patterns. He extracts the idea of trade-related international knowledge spillovers used in Grossman and Helpman (1991) and applies it to FDI. Production activities of MNCs in the low-wage countries are assumed to improve the efficiency of potential innovators in those countries. The knowledge spillovers of the MNCs' activities make innovation in the low-wage countries profitable. Allowing for imitation in the less developed country, the transfer of technology through

FDI stimulates active research and development (R&D) and growth. Therefore, Walz predicts that policies promoting FDI will lead to faster economic growth.

2. Spillovers and competition effects

In the previous section most of the theoretical models were confined to an ad hoc modeling of spillovers as they assume that technologies transferred would be fully beneficiary to a receiving country (or to a firm in this country), and that technologies can be transferred without facing any difficulties and adopted by local firms without paying any extra cost of adjustment.[7] Conversely, the models developed in this section recognize, in line with Wang and Blomström (1992), that transferring technologies within MNC and learning from foreign firms is a costly process.[8] When building their spillover model, Wang and Blomström explicitly identify two costs: (i) the cost to the MNC of transferring technology to its affiliates – this cost is assumed to be directly proportional to the vintage of the transferred technology, argument based on the results obtained by Teece (1977) – and (ii) the cost of learning to domestic firms in determining the amount of technology spillovers arising from the existence of foreign affiliates.

In addition, where in previous models the extent of spillovers is determined by the degree of foreign presence alone (contagion-type spillovers), in Wang and Blomström's model spillovers are instead endogenously generated by the technological competition between foreign affiliates and domestic firms (competition-related spillovers). In fact, Wang and Blomström model a differential game involving an MNC's affiliate and a local firm that are both able to influence spillovers, in which each firm solves its individual dynamic optimization problems subject to the other firm's action. They also follow Findlay's assumption of a positive relationship between the technology gap and spillovers, which generates the convergence-type spillovers. It is further argued that local firms and policies affecting their behavior play an important role in the technology transfer process. That is that the learning effort of a host country's firms plays an important role in increasing the rate at which MNCs transfer technology. Hence, spillovers effects tend to encourage technology transfer.

To model technology transfer through FDI, Wang and Blomström assume, on the supply side, the existence of two firms, a foreign affiliate and a domestic firm, which compete against each other by producing differentiated products for the domestic market. The products provide certain common Lancasterian characteristics,[9] but use different technologies. On the demand

[7] This is true, since technology to a certain extent has a public good nature which can be supplied without cost. However, technology has also a 'tacit' character as well as a codified character; neither can be codified in blueprints, nor be transferred easily to recipients (Nelson and Winter, 1982).

[8] There is no free copying of technologies in the world (Wang and Blomström, 1992).

[9] Details on Lancasterian characteristics are given in Lancaster (1966).

side, technology affects demand and represents the consumers' preference by the following logarithmic utility function

$$U(Y) = \alpha \ln K_d + \ln(Y_d + k^{\alpha} Y_f), \tag{2.1}$$

where the subscripts d and f respectively denote the domestic firm and the foreign subsidiary, K reflects the level of technological development of each firm, Y the quantity produced, $\alpha > 0$ – all products share the same α, and k the technology gap between foreign and domestic firms is expressed by the ratio $\frac{K_f}{K_d}$.

Considering that the price of each product is set proportionally to its marginal utility in equilibrium and setting the marginal utility of money equal to unity, it follows from equation (2.1) that the demand functions of the local and foreign firms are as follows

$$P_d = (Y_d + k^{\alpha} Y_f)^{-1}, \tag{2.2}$$

$$P_f = k^{\alpha} (Y_d + k^{\alpha} Y_f)^{-1}. \tag{2.3}$$

These equations show that foreign and domestic prices depend on the quantities and the relative attractiveness of corresponding products. The prices P_f and P_d are determined by the technology gap between the two firms. That is, the price of the MNC's affiliate's products increases with the technology gap, whereas the price of the local firm's products moves in the opposite direction:

$$\frac{\partial P_f}{\partial k} > 0 \text{ and } \frac{\partial P_d}{\partial k} < 0.$$

Competition among firms is represented by a Cournot game in which a firm decides the quantity to produce in order to maximize its profit, R, given the status quo of both the firm's technology levels and its competitor's current output

$$R_i(k) = Max\{P_i(k, Y_i, Y_j^*)Y_i - c_i Y_i \mid Y_i \text{ is feasible}\},\ i \neq j,\ i, j = f, d, \tag{2.4}$$

where $P_i(.)$ is given in equations (2.2 and (2.3), c_i is the marginal production cost of firm i, which is assumed to be constant for both firms, and Y_j^* is the Cournot-Nash equilibrium output of firm j.

The technological progress achieved by the foreign subsidiary is directly correlated to the resources I_f devoted to technology importing from the parent company

$$\dot{K}_f = I_f K_f, \tag{2.5}$$

where, for the sake of simplicity, the marginal productivity of the technological investment is assumed to equal unity.

For the domestic firm, its technological level also increases in response to its learning investment I_d, and the return of the investment diminishes as the learning effort increases. Yet, in the domestic case, Wang and Blomström also include Findlay's hypothesis in the learning process, wherein the rate of technological progress of the local firm is an increasing function of the

technology gap between its own level of technology and that of the foreign firm

$$\dot{K}_d = \Phi(I_d) k K_d \quad \text{with } \Phi^{'} > 0,\ \Phi^{''} < 0,\ \Phi(0) = v > 0, \tag{2.6}$$

where the constant v is the rate of costless technology spillovers.

The difference between equations (2.5) and (2.6) represents the change over time in the technology gap between local and foreign firms

$$\dot{k} = [I_f - \Phi(I_d)k]\, k. \tag{2.7}$$

that is, the technology gap between the firms grows as new technology is imported, but diminishes as a result of the local firm's learning efforts.

The foreign firm chooses $I_f(t)$ to maximize the discounted value of its profit subject to the transfer-absorption process (equation 2.7), given the learning effort of the domestic firm,

$$V^f = \int_0^\infty e^{-rt} \left[R_f(k) - C_f(I_f)\right] dt, \tag{2.8}$$

where r is the discount rate used by the foreign firm and $C_f(I_f)$ is the cost of technology transfer.

The domestic firm faces the problem of choosing I_d subject to equation (2.7) and the choice of the affiliate. This yields the function

$$V^d = \int_0^\infty e^{-\rho t} \left[R_d(k) - \theta C_d(I_d)\right] dt, \tag{2.9}$$

where ρ is the discount rate used by the domestic firm, $C_d(I_d)$ is the cost of learning investment, and $\theta(> 0)$ is a parameter denoting the costs-side efficiency of the learning process undertaken by the domestic firm. The smaller the θ, the more cost effective the domestic firm in its learning activities.

By solving the dynamic optimization problem (equations 2.8 and 2.9), Wang and Blomström find that:

(i) Spillovers are determined by the investment decisions of both foreign and local firms. Each decision has a direct effect on the technology gap and consequently on the amount of convergence-type spillovers. The more responsive the two firms quasi-rent to the technology gap, the more rapid and modern the technologies transferred, the more efficient the learning activities are and the more spillovers there are.

(ii) Given the learning efforts of host country firms, an MNC's incentive to transfer technology is negatively related to its perceived operation risks in the host country (industry).

Pursuing the work of Wang and Blomström, Nakamura (2002) finds, paradoxically, that there is the possibility that an increased spillover effect and an improved efficiency of the domestic firm's learning activities discourage technology transfer. In fact, as described by the following equations (2.10) and (2.11), an increase in spillover effects and efficiency of learning efforts accelerate technology transfer only if the elasticity of the foreign firm's

marginal quasi-rent with respect to the technology gap is larger than unity in absolute value and vice versa,

$$\frac{\partial I_f^*}{\partial c_d} = \frac{(\varepsilon_{Rf} + 1)\, R_f^{'}(k^*)}{c_f(r + 2I_f^*)} \frac{\partial k^*}{\partial c_d}, \qquad \text{with} \tag{2.10}$$

$$C_f(I_f) = (1/2)c_f I_f^2, \qquad C_d(I_d) = (1/2)c_d I_d^2$$

where ε_{Rf} $(= k^* R_f^{''}(k^*)/R_f^{'}(k^*))$ is the elasticity of the foreign firm's marginal quasi-rent with respect to the technology gap k^*, R_f is the foreign firm's quasi-rent function, I_f^* is the steady-state rate of foreign investment, k^* is the steady-state technology gap, and c_d and c_f denote the learning investment cost and the technology transfer cost, respectively. Because ε_{Rf} and $\frac{\partial k^*}{\partial c_d}$ are always negative, equation (2.10) generates the following relationship

$$\frac{\partial I_f^*}{\partial c_d} \gtreqless \quad iff \quad |\, \varepsilon_{Rf}\, | \gtreqless 1. \tag{2.11}$$

Another study that explores competition-related spillovers is by Perez (1997, 1998) who models this kind of spillover within an evolutionary perspective. He extends the dynamic model of Dosi et al. (1992) aimed at explaining the process of forging ahead and falling behind among countries by adding equations describing the interaction between foreign MNCs and domestic firms at the technological level. Thus, as in the Wang and Blomström (1992) model, the decision by foreign firms to import new technology depends on the existing technology gap (*Gap*) between foreign and domestic firms, while the imitation of foreign technology requires specific investment in learning.

More formally, the model assumes a closed-economy with only two interacting firms (foreign and domestic) existing in the industry. The market selection process is given by

$$\dot{f}_i(t-1,t) = \alpha\left[RC_i(t-1) - 1\right] f_i\,(t-1)\,, \tag{2.12}$$

with $\dot{f}_i$ standing for the growth of the market share of firm i and RC_i being its relative competitiveness vis-à-vis the foreign firm, where

$$\begin{aligned} f_i\,(t) &= \frac{Y_i\,(t)}{Y\,(t)},\ RC_i(t) = \frac{E_i\,(t)}{\bar{E}\,(t)},\ E_i\,(t) = \frac{1}{p_i\,(t)}, \\ \text{and}\ \ \bar{E}\,(t) &= \sum_i f_i\,(t)\, E_i\,(t)\,, \end{aligned} \tag{2.13}$$

with p_i as the price charged by firm i, Y_i its output, E_i its absolute competitiveness, and Y the total output. Each firm fixes prices according to a simple mark-up rule over labor costs

$$p_i\,(t) = (1+\rho)\frac{w_i\,(t)}{\pi_i\,(t)}, \tag{2.14}$$

with w_i as the nominal wage, π_i the real labor productivity, and ρ the mark-up.

Given that N_d^{IMI} and N_f^{IMI} denote respectively the number of domestic and foreign firms' workers engaged in imitation and N_d^{SEARCH} the number

of workers of domestic firms engaged in searching activity, the productivity changes of domestic (d) and foreign (f) firms, responsible for the increase of their market shares, are determined as follows[10]

$$\frac{\dot{\pi}_d\,(t-1,t)}{\pi_d(t-1)} = \mu_1 + \lambda_0[1-\exp(-\eta_1 N_d^{IMI}(t-1))]\frac{[Gap(t-1)]}{\exp\{\lambda_1[Gap(t-1)]\}} + \lambda_2[1-\exp(-\eta_2 N_d^{SEARCH})], \quad (2.15)$$

$$\frac{\dot{\pi}_f\,(t-1,t)}{\pi_f(t-1)} = \mu_2 + \delta_0[1-\exp(-\eta_2 N_f^{IMI}(t-1)]\frac{[1/Gap(t-1)]}{\exp\{\delta_1[1/Gap(t-1)]\}} + \delta_2\exp[-(Gap(t-1)], \quad (2.16)$$

with Gap as the domestic technology gap vis-à-vis its foreign MNC, proxied by the ratio of foreign productivity to domestic productivity; and μ_1, μ_2, λ_0, δ_0, η_1, η_2, λ_1, δ_1, and δ_2 as parameters.

The simulation of this model gives rise of some interesting results: highly technologically developed domestic competitors tend to maintain their competitive power by exploiting the learning effects associated with FDI. While backward domestic firms are instead likely to be almost completely crowded out by a rapidly growing foreign presence.

3. Spillovers and worker mobility

Theoretical models discussed in sections 1 and 2 assume that spillovers are either determined by the degree of foreign presence or endogenously generated by the technological competition between foreign affiliates and domestic firms. Yet, in line with Dosi (1988), we assume that a considerable part of technology is embedded in human skills and in their tacit capabilities, and so the movement of labor from foreign to domestic firms constitutes in some cases a channel of knowledge diffusion.

Three theoretical papers have recently modeled FDI spillovers through this channel. First, Kaufmann (1997) extends the Wang and Blomström's (1992) model by explicitly representing how information from the technological leader (the MNC) to the imitator (the domestic firms) could be transmitted. He suggests that one possible mean is the recruitment of MNC's employees by domestic firms.[11] Kaufmann also considers the resources used by each firm to influence its technological position. Two key results emerge from this model. Firstly, spillovers may either be generated or frustrated in the game between the MNC and the domestic firm depending on whether the marginal benefits of recruitment actions are greater or smaller than the marginal costs. Marginal benefits of recruitment are assumed to depend on demand parameters and the domestic firm's technological capability, while marginal costs are determined by internal MNC's wages. Clearly, lower

[10] Derivation of the Perez'a model is detailed in chapter 3 of his book (1998).

[11] Of course, we agree that the recruitment of MNC personnel is important for technology transmission, but demonstration effects are also a prerequisite for the technology transfer process and should be controlled for.

MNC's wages, higher domestic technological capability, and larger demand shocks increase the potential for spillovers in the domestic economy. Secondly, MNC transfers less technology and market prices are higher whenever spillovers are generated. Hence the effects of spillovers on the host country's welfare is generally ambiguous; this contrasts with the results of other spillover models (such as Wang and Blomström's), where host country welfare is improved by foreign investment.

Kaufmann's model can be outlined as follows. There are two players, as in games à la Stackelberg, a subsidiary of MNC (f) which is the leader and a domestic firm (d) the follower. The linear market demand curve in the initial period is given by

$$P = A_0 - (Q_{f0} + Q_{d0}), \tag{3.1}$$

where P is the market price and Q is the firm's output and A_0 is the intercept of the demand curve.

Assuming that no R&D funds are expended, or created, by either firm in the host country, new technologies can be introduced only through MNC's technology transfers which in turn are induced by a perturbation of demand in the host market, and technology is transferred within MNC at zero marginal cost. Then, after new technology is transferred (T_f), subsidiary production is given by

$$Q_{f1} = Q_{f0} + T_f. \tag{3.2}$$

Technology transfers will also lead to spillover gains in output if the domestic firm recruits some MNC's personnel. Then, the domestic production is

$$Q_{d1} = Q_{d0} + T_f L^r TC, \tag{3.3}$$

where $L^r \in [0, 1]$ is the fraction of the MNC's workforce that is recruited and TC is the technological capability of the domestic firm which is assumed to be an exogenous parameter. Equation (3.3) indicates that spillovers are positively related to the number of MNC's employees who are recruited and the level of domestic capability.

There are internal markets in the MNC for labor and technology where prices w_f and R, respectively, are set by the parent company and taken as a parameter by its subsidiary. The latter is allowed to set employee benefit levels (b) based on labor market conditions in the host country, so as to limit labor turnover induced by local firms. Given that MNC's workers differ in their relative valuation of wages and benefits because of personal characteristics δ_j like age and risk aversity, the utility, in terms of wages, of each MNC's employee j is

$$u_j = w_f + \delta_j b. \tag{3.4}$$

Assuming that the domestic firm attempts to recruit MNC's personnel by choosing a markup $m \geqslant 0$ over the internal MNC's wage w_f , a worker will migrate to the domestic firm if this latter offers higher wage than the MNC:

$$w_d = (1 + m)w_f > w_f + \delta_j b. \tag{3.5}$$

Similarly, a worker will leave the foreign firm to join the existing domestic one if

$$mw_f > \delta_j b. \tag{3.6}$$

The recruitment function is then defined as $L^r = \min[(\frac{mw_f}{b}), 1]$. Given that, the solution of the model is obtained from the maximization of the firms' profits Π^f and Π^d

$$\Pi^f = P(Q_{f1}, Q_{d1})Q_{f1} - RT_f - w_f(1+b), \tag{3.7}$$

$$\Pi^d = P(Q_{f1}, Q_{d1})Q_{d1} - L^r w_f(1+m). \tag{3.8}$$

The second paper is of Fosfuri et al. (2001) who, on the basis of their 1998 paper, analyze a model wherein MNC can transfer a superior technology to its affiliate only after having trained local workers.[12] Once trained, these workers can later be hired by a local firm and technology spillovers might occur. Even if such spillovers do not take place, the host country welfare might be improved because of so-called "pecuniary spillovers" embodied in the wages the MNC's affiliate pays to the trained workers to prevent them from moving to a local rival. Based on game theory, the Fosfuri et al. analysis focuses on conditions under which technology spillover effects occur. They find that these effects are more likely to happen when the local firm and the MNC do not compete fiercely in the product market (or sell in independent or vertically related markets),[13] when on-the-job training is general (such as organizational, managerial or marketing skills) rather than in firm-specific technology, and when the absorptive capability of the local firm is high (an argument similar to Kaufmann). The formal equations of the model are given in appendix 2.

Finally, Glass and Saggi (2002) construct an oligopoly model in which the MNC is assumed to have superior technology compared to local firms. If the MNC does FDI, technology may be transferred to the host firm if it hires workers who have been, instead of trained, exposed to superior technologies by working for the MNC. There is no room for training in this model. Recognizing the attractiveness of its workers to the host firm, the MNC weights the cost of paying higher wages to keep them within its boundaries against the benefit of limiting technology transfer to the host firm (an argument similar to Kaufmann and Fosfuri et al.). Glass and Saggi stress the fact that the premiums MNC pays to domestic workers are purely to control technology diffusion – no premiums are allowed due to training costs. An interesting point generated by this model is that the wage premiums paid by MNC may increase its profits by preventing the cost reduction of the host firm. Those premiums play an important role in controlling the technology diffusion process. Glass and Saggi's analysis points to the importance

[12] We also admit that the domestic employee who worked in MNCs without receiving any training courses could play an important role in transferring a part or all of the foreign knowledge.

[13] Note that recently, Ben Hamida (2006a) finds that worker mobility-spillovers from foreign affiliates palys an important role in enhancing the productivity of domestic rivals with low existing technological capacity.

of FDI promotion efforts which results in technology transfer to host firms increasing their profits or in wage premiums benefiting domestic workers.

4. Discussions

In this chapter we have discussed the diverse existing theoretical studies of spillovers for host countries. We recognized three strands of theoretical models; each one merely provides a partial description of FDI spillovers by restraining analysis to one means of these effects – i.e. direct contact-demonstration effects, competition effects, or worker mobility. In fact, in the first strand of studies, spillover benefits are simply determined by the degree of foreign presence in the industry – in this way, knowledge is diffused when foreign affiliates come into contact with existing domestic users by way of demonstration. While in the second strand, spillovers are rather endogenously generated by technology competition between foreign affiliates and domestic firms. In the most recent strand, spillovers are assumed to occur mainly due to the worker mobility.

This being so, none of the existing theoretical studies offers a complete theoretical description of intra-industry FDI spillover effects in which their diverse channels are altogether taken into account. In fact, since the amount and nature of the technologies transferred from foreign to domestic firms depend largely upon the mechanism by which they are transmitted – for example, worker mobility could transfer not only public technology but also tacit elements which are unlikely to be transferred through informal contacts between firms (Nelson, 1982), we strongly believe that the size and the extent of potential spillovers differ according to their channels. Therefore, it is our opinion that a more satisfactory model of spillover effects providing a deeper understanding of the process involved and the channels of knowledge transfer is still required so that the impact of this process will be exactly identified. As we shall note in chapter 3, the contradictory findings of existing empirical studies could be explained by the fact that a partial analysis of spillovers is not satisfactory and that a more complete picture of spillovers with respect to their diverse channels is needed to be able to correctly assess the effect of spillovers.

In addition, the theoretical literature suggests that spillovers are not automatic, but depend on the existing level of technology competence of domestic firms or their initial technology gaps. We are in agreement that this determinant is highly important in assessing spillovers, but as we shall see in chapter 3, further factors (for example, foreign technological characteristics, the type of FDI, the motives for foreign production, and the regional proximity between foreign and domestic firms) could also influence the amount of spillovers and should then be taken into consideration when modeling spillovers.

Moreover, most theoretical models on FDI and spillovers lie within the framework of industrial organization theory. Only Perez' (1997) model is based on the principles of evolutionary theory, although in our view, this theory is more concerned with the analysis of the determinants of the processes

of catching-up and backwardness wherein learning is considered a basis for technological change and economic growth. Spillovers emerge as learning activities succeed in increasing the firm's productivity.[14]

In this context, we develop in part 2 a theoretical model of spillover effects based on evolutionary theory in which we attempt to offer a more comprehensive picture of spillovers by distinguishing these effects according to the way they occur. Our model, as developed in chapter 5, hypothesizes that the size and the extent of such spillovers depend largely upon the interaction between the mechanisms by which they occur and the existing technological levels of domestic firms. Geographical proximity is important in determining the size and the extent of spillovers. Our theoretical model is tested against empirical evidence for Switzerland (part3).

Before introducing our theoretical model, we present in the following chapter, the existing empirical studies on spillovers.

[14]We have to add that this theory, as previously noted in chapter 1, has also been used by other international business scholars as Cantwell and Dunning to explain the dynamic of MNC activities.

CHAPTER 3

Existing empirical studies of intra-industry spillovers

The empirical literature of intra-industry spillovers was pioneered by Caves (1974), Globerman (1979), Blomström and Persson (1983) and Blomström (1986) using data for Australia, Canada and Mexico, respectively. Each of them hypothesizes that spillover effects should stimulate the productivity of competitors by increasing competition and/or by transferring foreign technologies to domestic firms. They postulate that if there is a positive statistical relationship between the productivity level of domestic industry and the share of foreign presence in that sector – the share of domestic industry's employment or value-added accounted for by foreign affiliates – then inward investment could be considered as a productivity raising force. Moreover, the productivity of foreign and domestic firms tend to converge over time. Building on empirical models, they use labor productivity or changes in labor productivity as variables to be explained which are regressed linearly, using a production function framework, on a number of explanatory variables, among them the share of foreign presence. Their set of explanatory variables includes among others capital intensity, labor quality, degree of concentration in the industry, technical progress, market growth, etc. Using manufacturing cross-sector data, all these studies yielded a positive and statistically significant coefficient on the foreign presence variable and concluded that spillovers exist at industry level, although they cannot say anything about the magnitude and scope of these spillovers.

Since then, the number of empirical studies assessing the incidence of intra-industry spillover effects on the productivity performance of domestic firms is fast growing (appendix 3) and the above models have been extended and refined, even though the basic approach is still, by and large, similar. According to appendix 3, we find that (i) existing available studies employ different datasets – cross-sectional and panel data – and vary in their level of analysis as some of them use firm level data, whereas many others use industry level. And (ii) most existing studies use either a contemporaneous level of foreign penetration or relatively short lags – most commonly a one year lag, and thus they usually assess the short run spillovers and not the long run effects.

According to Görg and Strobel's (2001) meta-analysis of 19 empirical studies relating to spillovers, cross sectional studies deliver more positive estimates of the spillover coefficients than panel data studies, but the latter is the most appropriate estimating framework as it allows for examining the development of domestic firms' productivity over a longer time period,

rather than relying on one data point, and for the control of time-invariant differences in productivity across sectors or firms. Meyer and Sinani's (2005) meta-analysis of 41 empirical studies of intra-industry spillovers affirms that cross-sectional analyses generate more positive spillovers because they do not control for possible reverse causality between FDI and productivity; those positive effects may be caused by MNCs investing in the more productive sectors in the host economy. Positive spillovers at industry level may be also the result of FDI inflows forcing less productive firms to exit and /or allowing multinationals increase their share of the host country's market, both of which would raise the average productivity in the industry rather than reflect genuine productivity spillovers (Javorcik, 2004).

Taking into consideration these methodological notes and using the same specification model as above, the evidence on significant spillovers is much weaker. Indeed, our appendix 3 (column 8) reports only eight studies employing panel data at firm level that support positive evidence for spillovers, viz. Yudayeva et al. (2000)[1] for Russia, Castellani and Zanfei (2001) for Italy, Meyer and Sinani (2002) for Estonia, Haskel et al. (2002) for the UK, Schoors and Van Der Tol (2002)[2] for Hungary, Barrios and Strobl (2002) for Spania, and Karpaty and Lundberg (2004) for Sweden. Whereas, the remaining studies report negative or insignificant spillovers, such as Haddad and Harrison (1993) for Moroccan firms, Aitken and Harrison (1999) for Venezuelan firms, Djankov and Hoekman (2000) for Czech Republic firms, Narula and Marin (2003) for Argentinean firms, Barrios (2000) for Spanish industries, and Lenger and Taymaz (2004) for Turkish industries.

We recognize three possible explanations for the negative or insignificant results of spillovers. First, spillovers do not occur automatically, but rather depend on local and foreign characteristics. Second, the foreign presence variable might be inappropriate to capture much of the spillover effects. It might also be nonlinearly related to domestic productivity. Third, spillovers are likely to depend on regional proximity between foreign and domestic firms.

The following three sections are devoted to discussing existing empirical studies that consider the above explanations in determining spillover effects. Section 1 deals with the notion of local and foreign characteristics, section 2 studies the question of measurement and linearity of spillover variable, and section 3 discusses the significance of the regional dimension.

1. Domestic and foreign characteristics

In this section, we present the various empirical studies that have suggested that a possible reason for the apparently contradictory findings from the country studies is that various domestic and foreign characteristics may influence the incidence of spillovers and should be taken into consideration when assessing spillovers.

[1] Yudayeva et al. also tested for inter-industry spillovers.

[2] Schoors and Van Der Tol also tested for inter-industry spillovers.

1. Domestic and foreign characteristics

1.1. Domestic characteristics: The absorptive capacity. The theoretical literature suggests that not all firms should be expected to benefit from spillovers from FDI (Das, 1987, Wang and Blomström, 1992 and Perez, 1997). In fact, domestic firms must possess sufficient levels of absorptive capacity to efficiently take advantage of spillovers. In other words, insufficient absorptive capacity may thwart critical learning processes at the firm which in turn would not benefit from new technologies (Cohen and Levinthal 1989, 1990). Absorptive capacity is the firm's ability to recognize valuable new knowledge, internalize it into its existing technological development, and modify it to fit its own specific applications, processes and routines. Then, the level of the firm's absorptive capacity depends upon its existing level of technological competence as well as its learning and investment efforts undertaken to be able to productively use new technologies. Respectively, Wang and Blomström (page 140) claim that "*although there is generally some degree of technology spillover between firms, there is no free copying of technologies in the word. Searching for information, reversed engineering, personnel training for new production methods, et cetera, make learning costly and time consuming*". Narula and Marin (2003) also suggest that absorption is not purely about imitation; domestic firms cannot absorb foreign knowledge unless they invest in their own research and development, because it can be highly specific to foreign firms since it is tacit in nature.

The theoretical argument discussed above has been broadly accepted by most later empirical studies so as to be able to assess significant spillover effects. Nonetheless, it is important to note that these studies disregard the significant role of learning and investment efforts in determining the absorptive capacity of domestic firms and retain in most cases the existing level of technological capacity or the technology gap between domestic and foreign firms as proxies. Two exceptions are Narula and Marin (2003) and Ben Hamida and Gugler (2006) who reported that only domestic firms that largely invested in the absorptive capacity received positive spillovers from FDI. Investment and learning efforts are proxied in Narula and Marin's paper by investments in new equipment for product/process innovation and training activities undertaken by Argentinean firms between 1992 and 1996, while in Ben Hamida and Gugler they are measured by the level of investment expenditures in new equipment and training activities for product/process innovation undertaken by Swiss firms within the period 1999-2001. Yet, the distinction of Argentinean firms according to different levels of industrial technology gap (high and small) does not provide any significant spillovers.

Cantwell (1989) advanced the idea that absorptive capacity of domestic firms is the key factor to determining the spillover benefits from the entry and the presence of foreign firms. He investigated the response of domestic firms to the increase in competition caused by the entry of U.S. multinationals into European markets between 1955 and 1975 and argued that positive spillovers occur only in industries wherein domestic firms had some traditional technological strength. Their analysis does not focus on productivity, but rather on changes in the market shares of foreign and local firms. Absorptive capacity is then proxied by domestic market share.

Using cross-section analysis for Mexican manufacturing industries, Kokko (1994) suggests that spillovers are related to the technology gap between locally-owned host country firms and MNC's affiliates. Technology gap is defined as the ratio of value-added per employee in foreign affiliates to that in private locally-owned firms. Kokko used the Caves's spillover model discussed above and furthermore allows for an interaction term between the share of foreign presence and the technology gap in order to assess the combined effect of this variable on industry labor productivity. He found that a large technology gap per se does not appear to hinder spillovers on average, although industries with a large gap and a high degree of foreign presence experience lower spillover benefits than others. However, Blomström and Wolff (1989) explicitly found that Mexican firms' productivity growth and the rate of their catching-up are higher in sectors where the existing technology gap between local and foreign firms is greater; this result accords well with Findlay's thesis of backwardness advantages.

Expanding on Kokko (1994), Kokko at al. (1996) examined more closely how spillover effects are related to the apparent technology differences between foreign and local firms. To do so, they used a cross-section of firm-level data rather than industry-level to be able to examine how the productivity of individual plants – not the industry average – are affected by the degree of foreign presence. Based on Uruguayan data, Kokko et al. found no significant evidence for productivity spillovers to the whole sample of firms. Nevertheless, once this sample is divided into two sub-samples characterized by the values of the technology gap, they found better results in which significant positive spillovers take place in the sub-samples of domestic firms with small and moderate technology gaps (measured as the difference between the domestic firm's labor productivity and the average labor productivity in foreign firms), but not in the sub-sample of considerably low technology firms. Kokko et al. assert on page 609 that "*small and moderate technology gaps seem to identify cases where foreign technologies are useful for the local firms, and where the local firms possess the skills needed to apply or learn the foreign technologies. Large gaps, on the other hand, may signal that foreign technology is not relevant (because the product varieties manufactured by foreign firms are very different from local varieties), that local firms have nothing to learn from the foreign firms, or that local technological capability is so weak that foreign technologies cannot be used in local firms*". An argument similar to Glass and Saggi (1998) who argue that the bigger the technology gap the lower the quality of technology transferred and the lower the potential for spillovers.

We recognize that several studies have confirmed the hypothesis that spillovers depend largely upon the technological characteristics of domestic firms and that only firms with relatively high technological capabilities experience positive spillovers. For instance, using panel data on domestic firms in Bulgaria, Romania, and Poland and panel data on UK manufacturing firms, respectively, Konings (1999) and Girma et al. (1999) found that on average there was no sign of spillover benefits – i.e., under the assumption that spillovers are homogenous across diverse types of domestic firms. However, while taking into account factors that could influence the capacity of

domestic firms to benefit from foreign presence, Konings reported evidence of positive spillovers only for R&D intensive firms and that in Bulgaria and Poland. And Girma et al. found that spillovers are positive and significant for all firms with low technology gaps (measured by the individual firm's total productivity factor gap relative to the 90th percentile TFP of the corresponding industry, in the previous year).

In a similar vein, using panel data for Portuguese manufacturing industries and cross-sectional data for US manufacturing firms, Flôres et al. (2002) and Yeaple and Keller (2003) found, respectively, that spillover effects are related to industries with an intermediate productivity gap (defined as the ratio of foreign firms' productivity to the productivity of domestic ones) and to relatively high technology industries (those with high level of R&D over sales). Liu et al. (2000) found, using panel data for UK manufacturing industries, that spillovers are more present in industries with low technology gaps and high technological capacities (proxied by intangible assets per worker). Based on cross-sectional data for manufacturing firms operating in Greece, Dimelis (2005) also provided evidence that only domestic firms with a small gap experience positive spillovers.

Using cross-sectional data for Chinese manufacturing firms, Buckley et al. (2002) found evidence for positive productivity spillovers for collectively-owned firms and negative spillovers for state-owned firms. They concluded that the former enjoys a superior capability to absorb external spillover benefits than the latter. Likewise, using panel data for Spanish manufacturing firms, Barrios and Strobl (2002) found little evidence for spillovers on average and strong positive effects in the sub-sample of domestic exporters. They interpreted this result as evidence that absorptive capacity (measured by export activity) matters. They argued that exporting firms which are more exposed to international competition tend to use more advanced technologies and hence are more able to capture spillover benefits than non exporters. However, based on a panel of Irish firms, Barry et al. (2005) failed to confirm the finding of Barrios and Strobl and provided evidence of negative spillovers for domestic exporters.

Damijan et al. (2003) analyzed firm level panel data for eight transition economies: Bulgaria, Czech Republic, Estonia, Hungary, Poland, Romania, Slovakia and Slovenia. They found that results for spillovers did not differ across countries and also reported no significant evidence for spillovers on average. Once they controlled for the domestic absorptive capacity, using an interaction term between the share of foreign presence and firm's R&D expenditure, they found some differences in results. For the Czech republic and Poland spillovers become negative, while they are positive for Romania. The result for the Czech Republic is in contrast to that of Kinoshita (2001), who found that spillovers become positive once absorptive capacity (proxied also by R&D expenditure) is taken into account. For all other countries, Damijan et al. found no evidence of spillovers at all. Castellani and Zanfei (2001) also failed to confirm the hypothesis discussed above which assumes that only domestic firms with relatively high technological capacity tend to benefit from spillovers from FDI. Using a panel of firm-level data on the

manufacturing industry in France, Italy and Spain they report the same surprising results as Damijan et al. They found that high TFP gaps favour positive spillovers, while a high level of absorptive capacity (proxied by the average productivity of the firm (TFP)) seems to inhibit such positive effects. This finding is contradictory to technological accumulation Cantwell's hypothesis which stresses the role of the domestic absorptive capacity and of the coherence between foreign and domestic technologies in determining the virtuous effects of inward investment.

The studies described above assume that spillover effects are linearly related to domestic absorptive capacity. Yet, some extensions allow for possible non linear specifications by which the parameter capturing the extent of spillovers will be a quadratic function of the absorptive capacity level of domestic firms. For example, in a study of cross-sectional data for UK manufacturing industries, Perez (1997) suggests that spillovers depend largely upon the absorptive capacity of UK firms, which in turn are affected by the level of foreign penetration and its rate of increase. Allowing for a quadratic relationship between UK spillover effects and the initial technology gap of UK firms (a proxy of absorptive capacity), he found an increase in productivity due to foreign presence only for industries in which domestic firms are characterized by high or very low levels of initial technology gap. Perez asserts on page 175 that "*in industries where a relatively wide technological gap is associated with a relatively low and slowly growing foreign share, indigenous firms may be able to catch up gradually. Conversely, where technological disparities are relatively modest but indigenous firms have to cope with a foreign presence that is too high or that grows too fast, the same firms may be unable to compete with foreign rivals and may enter into process of cumulative decline*". A similar argument has been put forward by Cantwell (1993) in his analysis of the interrelation between spillovers and technological capability .

Using firm-level data from UK manufacturing industry over the period 1989 to 1999, Girma (2003) also explored the nature of the absorptive capacity-technology spillovers nexus. He used three different specifications to assess the significance of absorptive capacity, viz. linear, quadratic and endogenous threshold models. He found that a minimum absorptive capacity threshold is crucial for domestic firms to be able to benefit from productivity spillovers. However the augmenting rate of spillovers diminishes as the absorptive capacity of domestic firms (proxied by the difference in TFP between an establishment and the maximum TFP in the industry) gets past the given critical level. The relationship between spillovers and absorptive capacity is then an inverted-U shaped; this kind of relationship remains invariable even when both foreign affiliates are located in the same region as the UK firms and outside the region. Girma claims that domestic firms with either very low or very high levels of absorptive capacity may be least likely to benefit from spillovers, as they either do not have the sufficient technological ability to do so or they are too similar in their technology to their foreign rivals. A similar argument has been put forward by Gomulka (1990) in the context of the technological catch-up of countries.

Using firm-level data from the UK manufacturing industry over the period 1980 to 1992, Girma and Görg (2005) allowed for different effects of FDI on domestic firms located at different quantiles of the productivity distribution by using a conditional quantile regression technique. In fact, in the presence of a heterogeneous productivity process, it is more appropriate to examine productivity dynamics at different points of the distribution rather than average properties (i.e. conditional means). They allowed for an absorptive capacity variable (proxied by the difference in TFP between an establishment and the maximum TFP in the industry) among the set of regressors, which is also quadratically related to the spillover effects. That is, even within a particular conditional quantile, the response of firm-level productivity growth to foreign presence is assumed to vary according to the initial level of productivity. Girma and Görg confirm the finding of Girma (2003) in respect that they found an inverted U-shaped relationship between domestic absorptive capacity and spillovers from FDI outside the region. Conversely, they provided evidence for U-shaped relationship coming from FDI located in the same region as UK firms.

1.2. Further domestic characteristics. A further factor discussed in the theoretical literature is the degree of competition in host markets, since spillovers are more pronounced in industries with stronger competition (Wang and Blomström, 1992).

Too often, existing empirical studies implicitly examine this argument along with the domestic absorptive capacity, i.e. industries with high level of domestic absorptive capacity are assumed to have high competition level. Few studies have explicitly analyzed this argument. Sjöholm (1997) examined FDI spillover effects on Indonesian manufacturing firms according to the local competition level of Indonesian industries. To do so, he estimated the same spillover model, as discussed above, using two sub-samples characterized by high and low values of domestic competition (measured by the interaction term between the Herfindahl index and the rate of effective protection). He found that Spillovers from FDI occur only in the sub-sample of Indonesian industries with a high degree of competition. Following Sjöholm's approach, Girma et al. (1999) also found that spillovers increase as the competition level (measured by import penetration index) of the UK industry increases.

In contrast, Chung (2001) found that competitive US industries experience productivity stagnation from FDI, while relatively uncompetitive US industries experience productivity growth. Chung asserts on page 224 that "*these findings are consistent with positive technology transfer occurring in less competitive industries where firms enter to exploit existing skills, and are consistent with less productive foreign firms entering more competitive industries to learn best practices*". To represent the level of domestic competition, Chung used the price markup; the ratio of price divided by marginal cost. When the price markup is high – a value greater than 1– competition is low.

1.3. Foreign characteristics. In addition, we recognize that another possible determinant of spillovers suggested in prevailing studies is that foreign characteristics could influence spillover effects. Accordingly, we identify seven different thoughts.

First, as we have noted in chapter 1, spillovers are assumed to largely depend on the structure of the MNCs's ownership. For example, Blomström and Sjöholm (1999) asked if the degree of spillovers vary with the degree of foreign ownership (majority, and minority). They used three different variables to measure the degree of foreign presence: the share of a 5-digit industry's total gross output accounted for by foreign firms (irrespective of majority or minority ownership), the share of an industry's gross output accounted for by firms with foreign minority ownership, and the share of industry's gross output accounted for by firms with majority foreign ownership. Using firm-level data operating in Indonesia in 1997, they found that the degree of foreign ownership does not seem to affect the amount of spillovers in Indonesia. Similarly, Dimelis and Louri (2002)[3] analyzed spillovers and their relationship to the degrees of foreign ownership (majority, and minority). They said (page 452) that "*the degree of ownership MNCs select is thought to affect the productive efficiency enjoyed by their affiliates as well as the diffusion of technology to local firms*". Using a sample of manufacturing firms operating in Greece in 1997, they found that positive spillover effects for the domestic economy stem exclusively from minority-owned affiliates, especially for the lower productivity domestic firms. This result contradicts Blomström and Sjöholm's findings for Indonesia. Dimelis and Louri suggest that these contradictory findings could be explained by the fact that the different development levels of the two economies (Greece and Indonesia) may affect the way they absorb the beneficial effects of FDI, that is in less developed economies any degree of foreign presence may have a significant impact while in more developed economies the effects are diversified.

Second, it is argued that spillovers depend on the complexity level of foreign technology. For example, Kokko (1994) tested spillovers, observed in a static cross-sector analysis of Mexican manufacturing, according to the complexity of MNC's technology. He used Caves' spillover model discussed above and also allowed for an interaction term between foreign presence and the complexity of MNC's technology (as proxied by either large payment on patents or high capital intensity) in order to measure the combined effect of this variable on industry labor productivity. He found that complex technology does not hinder positive spillover effects even when it is accompanied by large foreign market shares.

Third, existing studies also suggest that spillovers may be determined by MNCs' type of operations in the host country. Narula and Marin (2003) found that some MNCs operating in Argentina are able to generate benefits that are not based exclusively on the local exploitation of their own superior

[3]In their paper, Dimelis and Louri do not distinguish between intra-industry spillovers and inter-industry spillovers.

technological assets, but also as a result of superior transaction-type ownership advantages. Such operations do not seem to raise spillover benefits for local firms.

Fourth, as we have mentioned in chapter 1, productivity spillovers are largely determined by the motivations for FDI in that different types of FDI motives have markedly different amounts and signs of spillovers. Driffield and Love (2006a) tested this hypothesis for FDI flows into the UK from 8 leading countries over the period 1984-1995 and found supportive results. They found that spillover effects are positive when FDI is motivated by the desire to exploit some competitive advantage possessed by the UK and negative when FDI is motivated by the desire to access the technology of the UK's manufacturing firms. This result for the UK manufacturing industry seems to be confirmed by the work of Girma (2003), using more recent data between 1989 and 1999. In their 2007 paper, Driffield and Love confirmed once more the hypothesis that FDI motivated by different factors has systematically different spillover effects on domestic productivity. Unlike their 2006a paper, they developed a taxonomy of FDI motives, building on the key distinction between technology exploitation and technology sourcing, but also allowing for the locational effects of factor price differentials. They distinguished between four different types of FDI motivations: technology sourcing/location advantage, technology sourcing, efficiency seeking, and ownership advantage. And then they tested whether these different FDI motivations have different spillover effects, using datasets of FDI flows into the UK from 30 countries over the period 1987-1997. They found that the UK gains substantial spillover benefits only from FDI motivated by a strong technology-based ownership advantage – technology-sourcing FDI led to no spillovers.

Fifth, Liu and Wei (2006)[4] supported the hypothesis that foreign characteristics matter by highlighting the importance of distinguishing the source of FDI when determining spillovers. Using a sample of 10.000 Chinese and foreign manufacturing firms for the period 1998-2001, they found that foreign invested firms as a whole exert negative and insignificant spillover effects. After splitting the sample of foreign invested firms into OECD and Hong Kong, Macao and Taiwan (HMT) firms, better results emerged wherein spillovers became significantly positive with HMT-FDI, while they remained negative but significant with OECD-FDI. In a similar vein, Karpaty and Lundberg (2004) provided evidence that the nationality of foreign affiliates matters for the spillover effects. Using a panel of data for Swedish manufacturing firms, they found that US firms have a stronger positive effect on productivity of Swedish owned firms than FDI from the rest of the world. Likewise, based on Chinese industrial data for 2001, Buckley et al. (2007a) confirmed Liu and Wei's finding in that overseas HMT affiliates generate spillovers to domestic firms, but only in labour-intensive industries. Nonetheless, Buckley et al. also found that Western affiliates have positive

[4]Liu and Wei (2006) also examine inter-industry spillovers.

spillover effects and this on the performance of domestic firms in technology-intensive industries. In addition, they reported that Chinese state-owned enterprises gain spillover benefits from the presence of both HMT affiliates in labour-intensive industries and of western affiliates in technology-intensive industries. Other domestic firms (including, among others, collectively and privately owned firms), however, benefit only from HMT-FDI in labour-intensive industries.

Sixth, Kokko et al. (2001) investigated the role of the trade orientation of foreign investing firms in the size and the extent of spillovers. They noted that local market oriented foreign investors in Uruguay have apparently a stronger impact on domestic technology and productivity levels than export oriented investors. One reason could be that local market oriented MNCs may have relatively strong interactions with domestic firms, both as competitors and collaborators, whereas export oriented investors are likely to be relatively isolated from the local market.

Seventh, using data for industrial firms in Argentina over the period Marin and Bell (2006) tested spillover effects according to different affiliates' own technological activities and found evidence for positive effects when affiliates were technologically active. They claim on page 692 that "*not simply the existence of MNC subsidiaries, linked to the superior knowledge resources of the parent, generated spillovers. Instead, the subsidiaries' own knowledge creation and accumulation seems to have been a significant source of the spillover potential*".

2. Measurement and linearity of spillover variable

Four other possible explanations for the misspecification of spillovers are given in this section. First, some studies point to the possibility of taking an absolute variable for foreign presence rather than the relative one (the share of foreign to total sectorial activity). Second, there are studies that try to use as many proxies for foreign presence as possible so as to offer a careful examination of spillover effects – these proxies are treated as different channels or sources of FDI spillovers. Third, other studies assume that the foreign presence variable is not an accurate measure of the overall spillover benefits with respect to the entire effects of demonstration, competition, and worker mobility. And finally, the relationship between foreign presence and productivity spillovers may be non linear.

2.1. The measurement of spillover variable. As already mentioned, the absence of a significant and positive spillover effects from FDI could result in some troubles related to the measurement of the spillover variable itself. Firstly, foreign presence variable which has been used, by and large, to measure spillovers should not be measured by the share of the total activity in the sector accounted for by foreign affiliates. In fact, Castellani and Zanfei (2002) argue that this measurement imposes the restriction, that is changes of the same magnitude in foreign and aggregate activities within a sector have no effect on the dependent variable. They suggest instead the absolute level of foreign activity in the sector to measure foreign presence.

Using panel data on Italian firms, they found supporting results of positive spillovers with an absolute variable in place of negative spillovers with a relative variable. This measurement has been confirmed by Ruane and Ugour (2005) as they found that the spillover variable became positive and significant when they used the absolute rather than the relative measure.

Secondly, Tian (2007) suggested that foreign presence, as measured by the share of foreign firms in output, or the share of foreign firms in employment, or the share of foreign firms in capital as a proxy for spillovers tend to offer only a partial description of spillovers. That is, by employing only one of these three variables to proxy for the presence of FDI, the resulting estimates could not represent the overall spillover effects of FDI on the productivity of domestic firms – these proxies, in Tian's view, are considered sources of FDI spillovers. Instead Tian used a number of variables that represent different sources of spillovers. In terms of capital, he considered tangible assets and intangible assets as two different sources. Regarding products, new products were separated from 'traditional' products, and exported products are separated from domestically consumed products. And in terms of employment, he differentiated foreign firms employing skilled workers from those employing less skilled workers. Tian considered all of these variables as individual channels by which FDI may affect the productivity spillovers of domestic firms. Using panel firm data in China from 1996 to 1999, Tian found positive spillovers occur through tangible assets rather than intangible assets, via domestically consumed products rather than exported products, through 'traditional' products rather than new products, and from foreign firms employing unskilled workers rather than those employing skilled workers.

Thirdly, foreign presence variable could be inappropriate for capturing much of the competition-related spillover effects. Kokko (1996) asserts that spillovers from competition are not necessarily proportional to the presence of foreign firms, although demonstration and contagion effects are. Thereby, he suggests disentangling the effect of demonstration and contagion – which characterize the benefits of FDI through imitation of introduced foreign technologies and/or via worker mobility – from that of competition by employing technology and competition control variables. He estimated simultaneous equations for domestic and foreign firms and used the foreign presence variable to capture spillovers from contagion and demonstration effects and added a second spillover variable "the productivity of foreign affiliates" to reflect the effects of competition-related spillovers. By so doing, he found that spillovers are not determined by the degree of foreign presence alone, but rather by the simultaneous interactions between foreign and local firms.[5] Using the same methodology, Kokko's finding has been later confirmed by Lui et al. (2000) in their study of UK manufacturing industries. However, using US manufacturing data, Chung (2001) found evidence for spillovers from competition and technology transfer only for low competitive industries. Knowledge spillovers are determined as above by the degree of foreign

[5]We have to note that Kokko's results are only supported in a subsample of Mexican manufacturing industries wherein suspected enclaves – where foreign firms operate in isolation from Mexican competitors – were excluded.

presence, but competition effects are proxied by the growth of industry price markup.

Meyer and Sinani (2002)[6] also disentangled the effect of technology transfer from that of competition by employing technology and competition control variables. They also distinguished between technology transfer from demonstration and from worker mobility. To do so, they regressed the productivity of domestic firms on a set of explanatory variables, inter alia an interaction term between foreign presence and domestic absorptive capacity, foreign herfindahl index, and an interaction term between foreign presence and domestic labor skills; which capture demonstration, competition and worker mobility effects, respectively. Thereby, positive and significant coefficients mean that first, technology transfer from demonstration positively affects the productivity of domestic firms experiencing high absorptive capacity; second, competition induced by foreign presence negatively affects domestic rivals; and third, the movement of skilled labor from foreign to domestic firms contributes positively to raise the productivity of domestic firms. Using Estonian manufacturing panel data, they found that domestic firms benefit from the competition of foreign firms as the competitive pressure induces domestic firms to use their existing technologies more efficiently, or search for new ones, in order to maintain their market shares. Moreover, the coefficient of the interaction term between labor skills and foreign presence is found to be negative and significant. This provides evidence for a movement of skilled labor from domestic to foreign firms, which significantly harms the domestic firm output growth. And finally, only domestic firms with high absorptive capacity seem to benefit from spillovers from demonstration effects.

Likewise, Ben Hamida and Gugler (2006) also suggested that the assessment of the overall spillovers calls upon a detailed analysis of these effects according to their diverse channels. They tested this approach firstly for demonstration-related spillovers proxied as above by the degree of foreign presence, and they controlled for the influence of the level of domestic absorptive capacity in determining the size and the amount of such spillovers. That is, they tested spillovers according to the diverse levels of technological capacity of domestic firms and made use of a thorough measure of domestic absorptive capacity in which the learning and investment efforts of domestic firms came with their existing technological capacities. Using cross-sectional data for Swiss manufacturing and services/construction firms, they found evidence for spillovers only for Swiss firms with a mid existing technology gap and large investment in absorptive capacity.

2.1.1. *Worker mobility-related spillovers: A Survey.* It is worth noting that, recently, studies have been interested in measuring the spillover effects from the movement of trained and/or experienced local workers from a foreign affiliate to an existing or a new domestic firm "worker mobility-related spillovers". As MNCs' affiliates are highly active in training local employees, even more than domestic firms (Chen 1983, Wasow and Hill

[6]Meyer and Sinani also examine the effects of vertical linkages.

1986, Katz 1987, Djankov and Hoekman 2000, Sousa 2001). The types of training depend on the skills needed and range from on-the-job training to seminars and more formal schooling to overseas education, perhaps at the parent company (Blomström and Kokko 2002). And they affect most levels of employees, from simple manufacturing operatives through supervisors to technically advanced professionals and top-level affiliate managers. It is thus expected to some extent that the transfer of these skills and experiences to domestic firms will be broadly beneficial to them.

Based on an interview of 72 top and middle level managers in 41 manufacturing/processing firms, Gershenberg (1987) found that foreign affiliates offer more training of various sorts for their managers than private local firms (Kenyan firms in this case), and provided evidence for the movement of these trained managers from foreign to Kenyan firms that could contribute to the diffusion of know-how. However, mobility seemed to be lower for managers employed in the MNCs' affiliates than for those in Kenyan firms. This is not surprising given the common finding that MNC's affiliates pay their employees more than domestic firms (see for example Haddad and Harrison 1993, Aitken et al. 1996, and Görg et al. 2002). Bloom (1992) also found substantial technological transfer in South Korea when production managers left MNCs to join host firms. And Pack (1997) reported that in the chemical industry in Taiwan during the mid-1980s, almost 50 percent of all engineers and 63 percent of skilled workers left foreign firms to join domestic ones.

In a more recent paper, Görg and Strobel (2004) presented their first attempt at measuring and analyzing in detail the effects of worker mobility-related spillovers. They tested these kinds of effects at both intra- and inter-industry levels. Spillovers are proxied by three dummy variables, which in turn take one if the owner of the domestic firm had gained experience working for a multinational within the same industry prior to starting in the present firm, if he received training by multinational, and if his previous experience was gained in a multinational in a different industry. Using panel data on Ghanian manufacturing firms, they found evidence for spillovers from worker mobility only if the owners had experience in multinationals within the same industry. Vera-Cruz and Dutrénit (2005) supported this evidence,[7] in that firms created by former employees of the maquila industry[8] had more technological and managerial capabilities than other firms without this characteristic.

Using Chinese firm data, Hale and Long (2006) also tested for possible worker mobility-spillovers effects. To do so, he regressed the productivity of domestic firms on the degree of foreign presence in the industry within the same city and added another explanatory variable, the share of employees with foreign experience, by category of employees: production workers,

[7]Vera-Cruz and Dutrénit do not distinguish between intra- and inter-industry spillovers and use classification methods, viz. multiple correspondence analysis and hierarchical cluster analysis, to assess the spillovers from worker mobility.

[8]Maquila industry includes all of foreign firms, mainly from the USA, established on the border of Mexico and the United States.

engineering personnel, and managerial personnel. He found evidence that skilled labor mobility (engineers and managers) enhances positive productivity spillovers from FDI in China.

2.2. Linearity of spillover variable. Fourthly, the mixed results regarding spillovers can be explained by the fact that the relationship between productivity and the foreign presence variable may not be linear. Buckley et al. (2003) suggest that the finding of negative spillovers may be explained by the fact that they come to dominate over the positive effects. They clearly addressed the possibility of both positive and negative spillovers associated with the operations of MNCs: spillover benefits increase with foreign presence up to a point, beyond this, increased foreign presence may – at least in part – hinder the rate of growth of local firms' performance and then spillover benefits start to decline. Using a Chinese industrial census data for 1995, Buckley et al. found supportive evidence that the relationship between the degree of foreign presence and productivity spillovers is non linear and obtained rather a curvilinear functional form. Based on industry-level data from in 1997, Buckley et al. (2007b) also controlled for the impact of the nationality of ownership of foreign investors on spillovers. Doing so, evidence for a curvilinear relationship with FDI remains true only with data for overseas Chinese (Hong Kong, Macau and Taiwan) MNCs, but not for other (Western) firms. Buckley et al. found this relationship to be most pronounced for low-technology host industries.

3. Regional dimension

Given that labor mobility and imitation are among the important channels of spillovers, domestic firms that are located near to foreign affiliates may be more likely to benefit than others, since knowledge is transmitted more efficiently via local proximity and its transmission costs are assumed to increase with distance (Audretsch 1998). Thereby, spillover benefits tend to be captured firstly by neighboring domestic firms, and gradually spread to other, more distant ones (Aitken and Harrison, 1999). Then, if the spillovers are received by neighboring local firms only, spillovers are "regional" in scale, but, if they are also received by firms in other regions in the host country, then spillovers are "national" in scale.

Consequently, we recognize that a further possible source of the absence of significant and positive effects of productivity spillovers for domestic firms may be that the entry and presence of foreign investors generate spillovers, but only for firms located nearby. Then, when spillovers are measured at a national level, these regional benefits might not be identified if they are too small to offset the overall negative effects across all regions. To test for the possibility that spillovers occur at the regional level, one should include regional foreign share and that from outside the region in the specification rather than sectorial foreign share. Regional foreign share is measured by the share of "employment, value-added or capital" in an industry within a region employed by foreign firms.

3. Regional dimension

Aitken and Harrison (1999) advanced the idea that spillovers have a regional dimension. Using firm panel data for Venezuela, they find that regional foreign investment has positive and significant impact on the productivity of Venezuelan firms, while sectorial foreign investment has negative effects. Similarly, Liu and Wei (2006) found evidence of regional intra-industry spillovers from FDI, using firm panel data for China. Spillovers across Chinese regions are negative and insignificant; this may be due to the existence of barriers to the movement of production and output factors across regions in China. Also, using sector-level data in the UK, Driffield (2004) showed that there are positive productivity spillovers from FDI in the same region, while FDI outside the region has a negative impact on productivity. Driffield argues that this negative effect is consistent with a negative competition effect from foreign firms outside the region, which is not offset by the positive spillovers at the regional level.

Expanding on Girma et al. (1999) who found no evidence for national spillovers from UK manufacturing firms,[9] Girma and Wakelin (2002) examined in more detail whether spillovers from foreign to domestic firms have some regional dimension. Using panel data on UK manufacturing firms, they concluded that domestic firms gain from the presence of foreign firms in their region, but loose out if the firms are located in different regions. In addition, they supported the fact that local characteristics also influence the level of spillovers. Actually, sectors with high levels of competition and a low technology gap (as a proxy for absorptive capacity) experienced higher spillovers, and more-developed regions gain more from spillovers than others.

Girma and Görg (2005) also distinguished the effect of FDI in the same region from that of FDI outside the region. They also allowed, as described in previous sections, for different effects of FDI on firms located at different quantiles of the productivity distribution by using conditional quantile regression technique. They found, using firm panel data for UK, that the effect of an increase in the growth of FDI in the region has significant positive effects on TFP growth of UK firms in all quantiles, while the effects of FDI outside the region is largely negative. As in Girma and Wakelin (2002), Girma and Görg also considered in their specification the domestic absorptive capacity, which is quadratically related to the spillover effects. Doing so, they found U-shaped relationship between the absorptive capacity and spillovers from FDI in the region in all quantiles, while there is an inverted U-shaped relationship for spillovers from FDI outside the region. Conversely, as we have discussed above, Girma (2003) found that the relationship between spillovers and absorptive capacity is an inverted U-shape, either from FDI located in the same region as UK firms or outside the region.

Finally we have to note that there exist studies which failed to confirm that the regional dimension matters such as Sjohölm (1999) and Halpern and Muraközy (2005). Sjohölm examined Indonesian firms in 1980 and 1991 and found evidence of positive spillovers at the national level, whereas regional intra-industry spillovers from FDI were negative. Using panel data for Hungarian manufacturing firms, Halpern and Muraközy also find that

[9] See the description in subsection 1.1 of the study of Girma et al. (1999).

spillovers within or across regions were not different from each other, both were insignificant.[10] They attributed this finding to the fact that Hungary is a homogenous country from the viewpoint of spillovers because of its small size. Similarly, regional boundaries are not boundaries for spillovers.

4. Discussions

In this chapter we have discussed the existing empirical literature on spillovers for host economies. We have identified that although the number of empirical studies analyzing the incidence of spillovers is rapidly growing, results thus far have been mixed for country analyses and evidence on spillovers has not been conclusive yet.

What clearly comes out from the existing empirical literature on spillovers is that these effects occur through a variety of channels and thus the assessment of spillovers calls upon a detailed analysis of those effects according to the ways they occur. Spillovers are far from being proportional to the share of foreign presence. This variable does not take into account the effect of competition increase or that of worker mobility. This is one of the reasons why is contradictory the scant empirical evidence available. We believe that additional variables are required to provide a thorough analysis of spillovers in which the process of spilling-over is exactly identified.

We also find that the empirical evidence is quite supportive of the importance of domestic absorptive capacity in determining the magnitude and the scope of spillovers. Nonetheless, results are sometimes conflicting. This could be due to some troubles related to the measurement of the absorptive capacity itself, in that existing studies do not pay attention to the fact that the level of a firm's absorptive capacity depends upon its existing level of technological competence as well as its learning and investment efforts undertaken to be able to use new technologies productively. So, further investigations are needed to resolve these ambiguities and offer an appropriate measure of their absorptive capacity.

In addition, we recognize that the regional dimension which has been considered by a number of empirical studies has a significant role in assessing spillover benefits and that we highlight, as we previously mentioned in the conclusion of chapter 2, the importance of taking into consideration this dimension for the formal specifications of spillovers.

Thus, in our view, the assessment of spillovers calls upon a detailed analysis of the circumstances under which they emerge. Our study suggests that these effects tend to vary according to diverse factors, mainly spillover channels, domestic technological characteristics, and the geographical proximity between foreign and domestic firms. It suggests that the size and the extent of spillovers depend largely upon the interaction between the mechanisms by which they occur and the existing technological capacities of domestic firms, in that, as we explain in the following chapter, relatively

[10] Halpern and Muraközy (2005) also examined the regional inter-industry spillovers.

high technology firms are likely to benefit from spillovers through competition and/or demonstration effects, while domestic firms with relatively low technological capacity may gain a lot from worker mobility. It makes use of a thorough measure of domestic absorptive capacity in which the learning and investment efforts of domestic firms come with their existing technological capacities. And it allows for the assumption that spillover benefits could be regional. A detailed theoretical and empirical analysis of our approach used in determining spillovers are presented in parts 2 and 3, respectively.

Part 2

Our Theoretical Modeling of Intra-industry Spillovers from FDI

As noted in the previous part, the theory of FDI has been successful in explaining the existence and growth of MNCs' foreign investment. It has also detailed the effects of this investment and spillovers were identified as the most important benefits that host countries expect to get hold of. A large body of literature has developed over the last two decades which treats the concept of intra-industry spillover effects. However, too often, as we demonstrated in chapter 2, scholars offer a partial description of such spillovers since each of them analyzes merely one kind of these effects, viz. demonstration-related spillovers, competition-related spillovers, or worker mobility-related spillovers.

Just as spillovers have not been analyzed at the theoretical level as a complete picture with respect to their diverse channels, so empirical studies have also only given partial analyses of these effects. In fact, spillover effects are by and large measured by the share of foreign presence in the corresponding industry. Even if foreign presence seems to be an appropriate measure for spillover effects through demonstration, it cannot hold all the information about competition effects (Kokko, 1996) and about worker mobility (Ben Hamida, 2006b). This is one of the major reasons why there is contrasting evidence in the scant empirical evidence available (chapter 3).

Other possible reasons for the apparently contradictory findings from the country studies are: first, local characteristics may influence the incidence of spillovers, in that only high technology firms are likely to benefit from FDI spillovers, whereas locations characterized by low technological competence are not able to exploit the technological opportunities arising from foreign presence (Cantwell, 1989 and Wang and Blomström, 1992). And second, spillovers are likely to be more pronounced when domestic firms are located nearby their foreign counterparts. In fact, given that labor turnover and demonstration are among the most important channels for spillovers, domestic firms located nearby MNCs' affiliates may be more likely to benefit from foreign affiliates than other ones, since knowledge is transmitted more efficiently via local proximity and its transmission costs are assumed to increase with distance.

On the basis of spillover models presented in part 1, in this part, we develop a theoretical model which differs from existing ones with respect to three main points. Firstly, it offers a more comprehensive picture of FDI intra-industry spillovers by distinguishing these effects according to their diverse channels. Secondly, it recognizes that domestic technological characteristics influence spillover benefit, but differently from Cantwell's perspective it assumes that the size and the extent of this benefit depend largely upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. That is, relatively high domestic technology firms tend to benefit from spillovers through demonstration and/or competition effects, while small domestic technology firms which are not in a position to compete with foreign firms gain a lot from other forms of spillovers such as worker mobility, since this channel provides some assistance which can help domestic firms to better understand and implement foreign technology (Mody, 1989). This being so, we show that

even low technology firms may experience some spillover benefits from FDI and that only firms with very low technological competence, to a point that they are not capable of reaping profits via any of the spillover channels, enter into a process of cumulative decline and eventually leave the market. And thirdly, our model hypothesizes that spillovers are more likely to occur between neighboring firms than between other more distant ones.

We formulate our spillover model within an evolutionary approach since we view spillovers as a dynamic learning process – evolutionary theory is more concerned with the analysis of firm differences and dynamic change based on the learning process.

This part is organized as follows. Chapter 4 studies the evolutionary theory we use for the formulation of our model. Chapter 5 presents the model. And chapter 6 analyzes the simulation results.

CHAPTER 4

The evolutionary theory: a review

Certainly, understanding the great complex of cumulative change in technology and economic organization is the most important task in the area of economic history in a sense that it corresponds to the major determinant of how to promote economic development. A large body of literature has developed on the relationship between technological change and economic growth using diverse theoretical approaches. In particular, the core concern of evolutionary theory is with the dynamic processes by which firm behavior patterns and market outcomes are jointly determined over time; elements such as behavioral diversity, learning process, adaptation, and selection mechanisms characterize such processes. For example, the selective environment makes the link between the behavioral patterns and the realized growth patterns (Verspagen, 1993). Evolutionary theory was first expressed in the 1980s by management scholars (especially in Conner, 1991 and Wernerfelt, 1995) and later by economists (the seminal work of Nelson and Winter, 1982, Silverberg et al., 1988, etc.) and also by international business scholars such as Cantwell and Dunning who investigated the dynamic of MNCs' foreign activities and their effects (among other things spillovers) on the development of host economies. Formal models of spillovers using this theory were advanced by Perez (1997).

This chapter tries to give some insights into the basics of evolutionary theory by presenting in the first section its main outcomes in the field of economic dynamics and analyzing in section 2 the explanatory power of its models and its usefulness and applicability in the framework of FDI spillover analyses.

1. Towards an evolutionary theory

Before we explore evolutionary modeling, it is worthwhile to identify to what extent evolutionary theory differs from the neoclassic one and how it is useful in studying economic dynamics.

1.1. Classical and evolutionary perspectives in economics. Evolutionary theory provides a theory of firm differences and dynamic change based on learning, adaptation, and selection processes. Its basics have been mainly developed by the contributions of Nelson and Winter (1982), who started with a critique of standard production theory. As Nelson (1995, page 68) states, "*the evolutionary theories of economic growth ... all draw inspiration from Joseph Schumpeter*"; evolutionary contributions draw inspiration from Schumpeter's (1934) notion of disequilibrium dynamics resulting from

the introduction of innovations. In fact, Schumpeter described the disturbing effects of main technological breakthroughs on economic growth patterns by saying that key innovations are introduced in a process of creative destruction which drastically changes the structure of the capital stock in the economy. Schumpeter suggests that his own theory was intended to have the same kind of explanatory purpose for economics as Darwinian theory had for biology. He stresses the usefulness of biological analogies for economics.

Evolutionary approach tends to be at a variance with orthodox economic theory when it comes to exploring several notions such as equilibrium theory, profit maximization, representative firm, worldwide production function, and the act of reconciling. The basic tenets of evolutionary theory are outlined by Nelson and Winter (1982, page 4) as follows:

"*The firms in our evolutionary theory will be treated as motivated by profit and engaged in search for ways to improve their profits, but their actions will not be assumed to be profit maximizing over well-defined and exogenously given choice sets. Our theory emphasizes the tendency for the most profitable firms to drive the less profitable ones out of business; however, we do not focus our analysis on hypothetical states of industry equilibrium in which all the unprofitable firms no longer are in the industry and the profitable one are at their desired size. Relatedly, the modeling approach that we employ does not use the familiar maximization calculus to derive equations characterizing the behavior of firms. Rather our firms are modeled as simply having, at any time certain capabilities and decision rules*".

Thus, in evolutionary theory, firms are, first of all, assumed to try to enlarge their current profits by changing their behaviors and the motive for a firm's behavior is profit-seeking and not profit maximization. Firms, in evolutionary theory, are continually looking for how to improve their behavior and decision rules on the behalf of their profits. Secondly, rather than searching for a strategic equilibrium based on the concept of rationality, firms use boundedly rational behavioral procedures. Relatedly, the evolutionary principle of selection might be a useful substitute for market equilibrium (Nelson and Winter, 1982 and Silverberg, 1988). That is, the modeling approach that is employed by evolutionary economists does not use the rules based on maximizing the behavior of firms, rather, firms' behavior is modeled as simply relying, at any given time, on certain capabilities and decision rules. For that matter, Nelson and Winter (1982, page 4) added that "*Over time these capabilities and rules are modified as a result of both deliberate problem-solving efforts and random events. And over time, the economic analogue of natural selection operates as the market determines which firms are profitable and which are unprofitable, and tends to winnow out the latter.*"

The capabilities and decision rules characterizing firms' behavior are then modified over time as a result of both deliberate problem-solving efforts and random events. And like the natural selection of genotypes in biology, the (past and present) sets of decision rules and capabilities determine, by means of a market selection mechanism, which firms will grow and

which will loose their position in the market. Given these assumptions, evolutionary theory rejects the notions of worldwide production function and the representative firm of a simple neoclassical sort, necessary to calculate market equilibrium.

Lastly, the orthodox formulation offers no possibility of reconciling analyses of growth at the economy- or the sector- levels with what is known about the process of technical change at the microeconomic level. Instead, evolutionary formulation provide a fruitful integration of what goes on at the micro level with what goes on at a macro level, when analyzing, of course, the processes involved in technological change.

1.2. The use of an evolutionary perspective in economics. Obviously, the use of an evolutionary theory in the analysis of economic phenomena stems from the need for providing a theoretical scheme for the relationship between technological change and economic growth, best representative of the empirical reality. This theory provides fruitful analyses in the field of economics of technology and growth; it looks at the dynamics of the economic system (firm, industry, market, etc.) as an adaptative dynamic system based on its existing line of technological development and its motivation to invest in learning. The firm, for example, is considered an information processor that facilitates its ability to adapt and process new information. The firm's rule-based behavior and routines represent the principle bases of the evolutionary paradigm of the firm concerned with change and development over time. Nelson and Winter (1982) recognize three kinds of routines[1]: first, the "operating characteristics" related to what a firm does in the short run; second, the routines that determine the period-by-period changes in the level of a firm's capital stock; and third, the routines which operate to modify over time diverse aspects of the "operating characteristics". Rules are generally used to make decisions about investment in (the search for) new technologies by typically undertaking either innovating or imitating activities.[2] Accordingly, outcomes emerge that are sometimes positive and sometimes negative according to the firm's ability to succeed in learning – these outcomes are the best the firm could do, given the uncertainty it faces. Firms whose behavior yields to a competitive power survive and increase their market shares and others loose their position in the market. This result leads to a new market structure derived by the market selection process.

As a matter of fact, evolutionary processes in economic environments involving innovation and diffusion are governed to some extent by selection and learning mechanisms. Dosi et al. (1992) define learning as a process by which repetition and experimentation enable tasks to be performed better and quicker and new production opportunities to be identified. Learning

[1]More Detailed information on these routines is given in Nelson and Winter (1982), pages 16-18.

[2]Note that if technological accumulation in the firm is continuously raising its productivity or lowering its costs along a given line of technological development, then no firm would remove its existing pattern of innovation and introduce technological knowledge of another (Cantwell, 1999 and Silverberg and Verspagen, 1994b).

arises as a result of either innovating or imitating better technologies, depending on the technological capacity of the firm. As learning activities succeed in increasing the firm's productivity, its competitive power will be improved as well. Learning is presumed to have several key characteristics: it is a cumulative process in that the sensibility of a firm's growth rate to either prosperity or difficulty is a reflexion of its genes; it involves organizational rather that individual skills; it is an essentially social and collective phenomenon; and it requires common codes of communication, especially when it comes to imitating activities. Silverberg et al. (1988, page 1034) adds that "*learning processes generally occur via (a) the development of intra- and inter-industry externalities (which include the diffusion of information and expertise, interfirm mobility of manpower, and the growth of specialized services); (b) informal processes of technological accumulation within firms (of which learning-by-doing and learning-by-using are the best known examples of such internalized externalities); and (c) processes of economically expensive search (R&D being, of course, the best example)*".

As what the selection mechanism refers to, Nelson and Winter (1982) suggest that the evolutionary principle of selection might be a useful substitute for market equilibrium. This economic selection mechanism is analogous to the natural selection of genotypes in biology. The general idea behind the principle of selection is that it is based on differences in microeconomic behavior. Those differences are the strong driving force of the economic system. In fact, each economic agent or unit, e.g. firm, is assumed to have some specific degree of competitive power which stems from its past behavior and hence differs in general between firms. By way of the selection process, agents whose (past an a present) behavior resulted in highly competitive power will grow (in terms of market share or profits), and others will loose the race, eventually forcing them to leave the market. This selective environment makes the link between behavioral patterns and realized growth patterns (Verspagen, 1993).

To sum up, we could say that selection mechanisms tend to increase the economic dominance of some firms – e.g. profitability, market shares – with particular technological characteristics at the expense of others; while learning mechanism, on the other hand, may both spread innovative/imitative capabilities throughout the (possibly changing) set of potential adopters and reinforce existing disparities via cumulative mechanisms internal to the firm (Silverberg et al., 1988). This being so brings in both selection and learning processes that are highly likely to be interdependently determined.

2. The explanatory power of evolutionary modeling

In what follows, we shall give a general description of how scholars have represented evolutionary theory in more formal models (section 1) and we will discuss the need for evolutionary modeling in the context of spillovers (section 2).

2. The explanatory power of evolutionary modeling

2.1. The general modeling. It seems natural that when we think about evolutionary modeling rooted in the Schumpeterian tradition we ought to start with the work of Nelson and Winter (1982) from which several types of evolutionary models have been developed. Nelson and Winter, as stated by Andersen (1996), made an evolutionary synthesis by integrating ideas about behavioral patterns and their transmission, the creation of new behavioral patterns, and different types of selection mechanisms. The state of the evolutionary process of an industry at any moment (t) is described by the capital stock and the behavioral rules of each firm. The state in the next moment ($t + 1$) is determined by the state in the previous moment. Figure 4.1 below summarizes the computational structure of the most developed and documented Nelson and Winter model type which deals with the evolution of the production techniques and other behavioral rules of an industry producing a homogeneous product.[3] The computational steps of the figure describe how the state of the industry in the next period ($t + 1$) is found when the state of the current period (t) is given.

At any particular time t, the capacity utilization rules of firms and the magnitude of their capital stocks and other state variables determine their input and output levels. Output of the industry is found by simple aggregation. Given demand conditions, e.g. a conventional downward-sloping market demand curve, the market-clearing price per unit of output is then determined. The profitability of each firm is then determined. The firm's behavioral rules include the search for both innovation and imitation. The firm's chance of getting a 'draw' (a successful innovation or imitation technique) is proportionate to its related search costs as well as to the exogenously given character of technical change in the industry. For the following period, the firm chooses to use the technique with the highest productivity. A firm's desired expansion or contraction is determined by its profitability, its desired investment, and its investment constraints. A firm that has price equal to cost, zero R&D expense, and hence zero profit will have zero net investment. The investment process has no time-lags. The adjusted physical capital stock is available to the industry's firms in period $t + 1$. By multiplying the capital stock with the new level of productivity, we have the production capacity of the industry's firms in period $t + 1$. And so the computation goes on and on for $t + 2$, $t + 3$, etc.

Since the publication of the seminal work of Nelson and Winter in 1982, evolutionary models proliferated enormously which frequently used Nelson and Winter models as bases. All of these models are dynamic ones, focused on far-from-equilibrium analysis, and based on the concepts of diversity and heterogeneity among economic agents (firms) and their behaviors. Search and selection are simultaneous interacting aspects of the evolutionary process; through their joint action the firms evolve over time.

According to Kwasnicki's (2002) comparative analysis of evolutionary models in the Schumpeterian tradition, there exist three main streams of modeling efforts which are slightly related but in some way independent.

[3] More formal specifications of the Nelson and Winter model type are given in Nelson and Winter (1982), chapter 12.

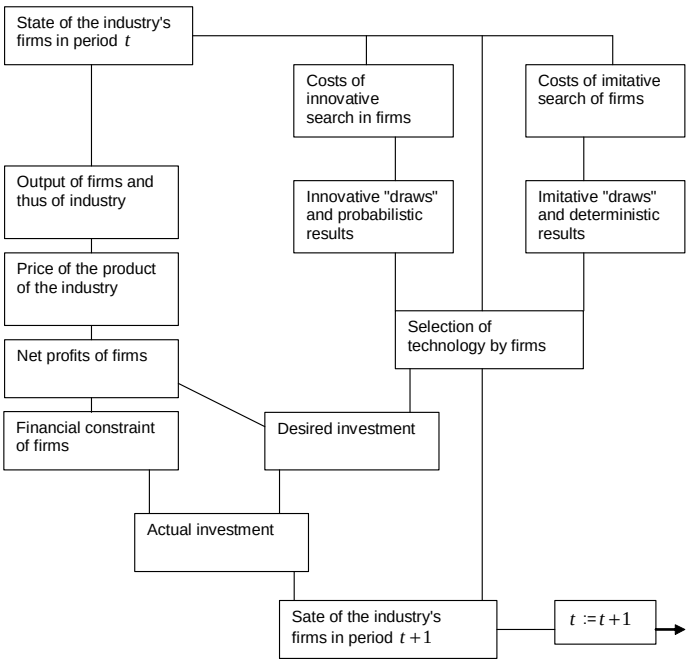

FIGURE 4.1. The computational structure of the typical Nelson-and-Winter model, source: Andersen, 1996.

The first is very closely associated with the work of Nelson and Winter (1982), e.g. Winter (1984), Yildizoglu and Jonard (1999), Winter et al. (2000), and Yildizoglu (2001). The firm in this kind of model is the basic unit of evolution and the product is the unit of selection, given that, selection goes through price mechanism. Price is set as uniform for all firms, the price and different production costs generate diverse profits which in turn govern investment abilities of firms and then generate a variety of growth rates. Among the economic phenomena explained by these models, Yildizoglu and Jonard, for example, explore the influence of localized learning and externalities on industry dynamics.

In the other streams, the firm is both a unit of evolution and a unit of selection. Selection is modeled using different forms of the replicator equation; most of them are based on competitive selection. The second stream refers to the Silverberg and Verspagen models (SV models), e.g. Silverberg et al. (1988), Silverberg and Lehnert (1993), Silverberg and Verspagen (1994a, 1994b, 1995). These papers explore (with an evolutionary approach) the relationship between endogenous technological change and economic growth. In this respect, Silverberg et al., for example, analyze the nature of the diffusion process of new technology, in which two technological trajectories are considered, learning by doing and learning from the experience of others. The diversity in a firms' capabilities and expectations about future developments is the main element driving the diffusion process. The third stream of

models is called the Dosi et al. models, e.g. dosi and Chiaromonte (1992), Dosi and Fabiani (1994), and Dosi et al. (1994). In these studies scholars address questions about convergence (catching-up) and divergence (forging ahead and falling behind). Dosi and Fabiani develop a model showing how evolutionary microfoundations easily allow for the emergence of divergent patterns of growth (catching-up, falling behind, overtaking) and their persistence.

One distinguished feature of Dosi et al. and SV models is that the selection mechanism is described by the replicator equation.[4] This way of modeling borrows heavily from the biological and ecological methods wherein selection dynamic is given by:

$$\dot{X}_i = \alpha X_i(E_i - \bar{E}), \tag{2.1}$$

with

$$\bar{E} = \sum_i X_i E_i, \tag{2.2}$$

where X denotes the share of an individual (species) i in some variable, E is competitiveness, and a bar indicates an average level. Thus the replicator equation shows that the proportional rate of growth of the share of an individual is a function of the difference between this individual's competitiveness (E_i) and average competitiveness ($\bar{E}$).

2.2. The use of evolutionary modeling in studying spillovers. As previously noted, one of the interesting fields of applicability of evolutionary theory is convergence and divergence phenomena, wherein attention in most of the case studies is tied closely to the analysis of the determinants of the processes of catching-up and backwardness. These processes are mainly related to the literature of technology gaps, emphasizing learning as a basis for technological change and economic growth. One reason is that learning is obviously the major driving force leading to a narrowing of the technology gaps between agents (e.g. firms), permitting them to catch-up. This mainly occurs when firms have inherited strong technological traditions from the past, essential for their best technological development, which will raise their productivity level.

Spillovers emerge as learning activities succeed in increasing a firm's productivity. It may turn into either virtuous or vicious circles of technological development in locations affected by, for example, foreign MNC's activity, depending on the existing level of domestic capabilities. In this respect, market selectiveness will ensure the survival of the relatively homogenous firms in terms of technological competence and drives the firms that lag far behind the technological frontier out of the industry. Heterogeneity among firms (e.g., between foreign and domestic firms and/or within each group of

[4]Note that this replicator equation was used in Perez' (1997 and 1998) spillover model and we consider it in the formulation of our model as well (chapter 5).

firms) is then explicitly recognized as the cause of evolutionary paths, driven by market selectiveness.

The evolutionary theory was first discussed within the context of MNCs by Cantwell (1989, 1991a,b, 1993, and 1994). He analyzed international production with an evolutionary perspective to explain the dynamic of MNC's activities; he developed the technological accumulation approach in which the internationalization of production is linked to the ability of firms to accumulate, integrate, and control ownership advantages across national boundaries[5] – the growth of MNCs' activities is linked to the process of technological accumulation within the firm. In page 18 of his book, Cantwell (1989) states that "*the theory of technological accumulation emphasises the cumulative characteristics of innovation...Even radically new technologies, once they move beyond the purely scientific and experimental stage, often rely upon or are integrated with earlier technologies in the course of their development*".

Dunning, along the evolution of his OLI thinking, has also incorporated an evolutionary aspect into this paradigm to be able to take into account the dynamics of MNC's activities. He has applied the eclectic paradigm to analyzing the way in which MNCs both generate and respond to technological change.[6] Similarly, Kogut and Zander (1993) were concerned with the analysis of the growth of MNCs and examined to this end the technology transfer process from mother company to its affiliates. They found that MNCs are specialized in the transfer of relatively tacit and idiosyncratic knowledge; such findings seem to be consistent with the broader evolutionary perspective.

When analyzing the dynamic path of foreign production, Cantwell and Dunning explicitly discuss the effects of that production on the development of host economies and afterwards on the embeddedness level of MNCs. In this context, Cantwell (1989, page 2) asserts that " *in order to capture this kind of effects it is necessary to shift away from the approach of 'industrial organisation', and towards that of 'industrial dynamics'*". Cantwell discusses, among other things, the spillover effects of foreign investment and asserts that those effects are subject to the absorptive capacity of domestic firms – spillover benefits occur only for domestic firms with higher absorptive capacities. He investigates the response of local firms to the increase in competition caused by the entry of U.S. multinationals into European markets between 1955 and 1975 and argues that positive spillovers occurred only in industries where local firms had some traditional technological strength. Relying on Cantwell's spillover analysis, Perez (1997) developed a model of spillover effects using an evolutionary perspective. He emphasized the catching-up process as a path-dependent corporate learning process, in that the absorptive capacity of local firms, which depends on their past process of

[5]Details of the technological accumulation approach are given in chapter 1.

[6]It is worth noting that Dunning has introduced this evolutionary element into his work on foreign investment since 1979 when he developed the investment development path which explores the question of FDI growth from the perspective of countries rather that firms.

technological accumulation, is the major cause of virtuous or vicious circles of technological development. Spillovers emerge as a result of a dynamic interaction between foreign and domestic firms at the technological level. More formally, Perez extended the dynamic model of Dosi et al. (1992) aimed at explaining the process of forging ahead and falling behind among countries by adding equations describing the interaction between foreign MNCs and domestic firms at the technological level. Thus, as in the Wang and Blomström (1992) model, the decision by foreign firms to import new technology depends on the existing technology gap between foreign and domestic firms, while the imitation of foreign technology requires a specific investment in learning. Simulation results of Perez's model show that highly technologically developed domestic competitors tend to maintain their competitive power by exploiting the learning effects associated with FDI, while backward domestic firms are instead completely crowded out by a rapidly growing foreign presence.

In the following chapter, we develop an evolutionary model of spillovers based on evolutionary theory. We embed the question of spillovers from MNCs into a larger one by allowing for the different mechanisms by which domestic firms benefit from FDI; domestic firms may choose to innovate or imitate foreign technologies according to their technological competencies. Domestic firms may choose to acquire the best foreign practice technology via either the demonstration mechanism or the recruitment of domestic employees already trained by or having worked in multinationals. Successful learning drives domestic firms to improve their competitive power relative to their foreign counterparts, which is more pronounced in locations where both firms are geographically close.

3. Conclusions

In this chapter we have presented the evolutionary theory we use in the next chapter to formulate our spillover model. We have explained that the basics of this theory have been mainly developed by Nelson and Winter in their seminal work of 1982, wherein they expressed their dissatisfaction with standard production theory based on the equilibrium approach to explain the dynamic of economic growth resulting from the introduction of innovations. We recognize that this theory looks at the development of economic systems (firms for example) as an adaptative dynamic system based on its existing line of technological development and its motivation to invest in learning, so as to upgrade its competitiveness. Doing so, we show that evolutionary theory offers a theoretical scheme for relationship between technological change based on learning and adaptation, and economic growth; the best representative of the empirical reality. This is the reason why we make use of the foundations of this theory to develop our spillover model based on elements such as behavioral diversity, learning, and market selectiveness to characterize the spilling-over process and the resultant economic change. Details about the features (our hypotheses) as well as the equations of our spillover model are given in the next chapter.

CHAPTER 5

Our evolutionary model of intra-industry spillovers

As shown in the previous chapters of part 1, the main feature of the models of productivity spillovers from FDI is that spillovers are determined by the share of foreign presence and the technological characteristics of domestic firms. This conclusion evidently contrasted with the majority of the recent literature: on the one hand, spillovers do not only result from the exposure of domestic firms to the entry and presence of foreign firms, but also from both the technological competition between foreign and domestic firms and the movement of domestic workers previously trained by and/or having worked at MNCs to domestic firms. On the other hand, there exist other factors besides the technological characteristics of domestic firms that condition the size of spillovers: the geographical proximity between foreign and domestic firms.

In the model we develop in this chapter, we have tried to bridge the gap by including, within an evolutionary model of productivity spillovers from foreign affiliates, the diverse spillover mechanisms, the technological characteristics of domestic firms, and the geographical proximity, that we think represent the major determinants which influence the size and the extent of spillovers. In fact, our model differs from previous ones with respect to three main points: firstly, it offers a more comprehensive picture of FDI intra-industry spillovers by distinguishing these effects according to their diverse channels. Secondly, it hypotheses that the size and the extent of such spillovers depend largely upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. Thirdly, it argues that geographical proximity plays an important role in determining the size and the extent of spillovers. Spillover benefits tend to be more pronounced in locations where domestic firms are close to the foreign firms, so that as geographic distance increases, spillovers have a tendency to decrease. Our hypotheses are later tested against the empirical evidence for the Swiss economy (in part 3) using both qualitative and quantitative analyses of data from manufacturing and services/construction.

This chapter is organized as follows. The first section reviews the determinants of the impact of FDI on the technological development of domestic firms – viz. spillover mechanisms, domestic technological characteristics, and geographic proximity between foreign and domestic firms; while the second section develops a theoretical model that is consistent with these determinants.

1. FDI and intra-industry spillover effects: the set of features

Before we introduce the equations of our model, it is worth analyzing three main factors mediating the size and the extent of spillovers: spillover channels, domestic technological capacities, and geographical proximity.

1.1. FDI and spillover channels. Generally, productivity spillovers are said to take place when the entry or presence of MNC's affiliates leads to productivity or efficiency benefits in the host country's local firms, and the MNCs are not able to internalize the full value of these benefits (Blomström and Kokko, 1998). Spillovers may materialize through three channels: demonstration-imitation, movement of domestic labor who have been trained and/or worked at the MNCs's affiliates, and the increase of competition. Domestic firms may improve their productivity when the foreign firms, after entering the domestic market demonstrate their advanced technologies, which may later adapt and imitate them; when the increase of competition, that results from the entry and existence of foreign firms forces domestic firms to work harder or introduce new technology; and when domestic workers who were trained by or worked in the MNCs' affiliates (denoted here by "MNCs' labor") may decide to leave the firm and join an existing or open up a new domestic firm, taking with them some or all of the firm specific knowledge of the MNC. In this latter case, foreign affiliates are unlikely to be mute spectators as their technological secrets are disseminated to their domestic rivals; they choose to pay the "MNCs' labor" a benefit level (called a non-wage compensation) in addition to the direct wage in order to prevent them from leaving the firm. Then, in order to gain access to foreign technologies with personnel assistance, domestic firms should pay "MNCs' labor" a wage mark-up superior to the benefit level (Kaufmann, 1997).

Obviously, the importance of FDI spillover effects depends broadly upon the mechanism by which they occur, given that: on the one hand, firms differ in their technological competence and in turn they differ in their choice of the way to benefit from the presence of FDI. Then, the relevance of each spillover mechanism, as we shall see in the following section, varies with the technological characteristics of domestic firms, in that if technological accumulation is continuous in each domestic firm, raising its productivity or lowering its costs along a given line of technological development, then no firm would abandon its existing pattern of innovation and imitate the technological knowledge of foreign competitor (Cantwell 1999 and Silverberg and Verspagen 1994b). On the other hand, the amount and nature of the technologies transferred from foreign to domestic firms depend largely upon the mechanism by which they are transmitted. That is, spillovers via worker mobility for example are likely to be higher than through demonstration effects, since worker mobility can lead to substantial improvements in productivity throughout the local economy by transferring not only public technology (the so-called "the logy"), but also the tacit element ("the technique") that is unlikely to be transferred through informal contacts between firms.[1] As

[1]Wojnicka (2004) asserts that the mobility of labor is a source of tacit knowledge essential for innovativeness and competitiveness of local enterprises.

stated by Nelson (1982, page 467) "*research and development scientists from rival firms give papers at meetings of professional societies. They meet together for lunch to exchange information on the evolving frontiers of the logy, while trying to avoid disclosing details of particular techniques their firms may have under development at the time*".

Thus, we strongly believe that the assessment of the existence and the extent of spillover benefits for a given firm, industry, or country calls upon a detailed analysis of these effects according to the ways they occur. A large body of literature (theoretical and empirical) has over the last two decades developed the concept of intra-industry spillovers. Nonetheless, most of the studies offered only a partial description of FDI spillovers, since each of them focuses on analyzing only one kind of these effects. Few exceptions, which mainly are the contributions of Kokko (1996) and Meyer and Sinani (2002), note that the absence of a significant and positive effect of foreign investment on the productivity level concluded by a great amount of studies can be explained by the fact that the variable "the share of foreign presence", which has been, by and large, used as a measure of spillover effects from FDI (e.g. by Kopecky and Koizumi 1977, Findlay 1978, Kokko 1994, Girma et al. 1999, and Buckley et al. 2002), seems to be inappropriate to capture much of the competition and worker mobility effects. They suggest disentangling the effect of demonstration and worker mobility from that of the competition by employing technology and competition control variables. Such modeling strategy is likely to describe more correctly the process of spilling-over and then identify with accuracy the nature and the size of the resultant effects. Our model developed here is well suited for this purpose; it is, to our knowledge, the first theoretical attempt at modeling this idea.

1.2. Domestic technological capacity and spillovers. It is well known in the literature on FDI spillovers that the absorptive capacity of domestic firms is, by and large, the most important determinant of spillovers. This concept encompasses the firm's ability to recognize valuable new knowledge, internalize it into the firm and use it productively. To be able to utilize the knowledge of foreign investors and then increase their productivity, domestic firms have to make some training and investment efforts. Only firms possessing sufficient levels of absorptive capacity are likely to efficiently exploit spillovers (Wang and Blomström, 1992). The diffusion of knowledge across borders may be limited because of the low absorptive capacity of potential recipients located abroad (Rugman and Verbeke, 2001).

Besides imitation, we recognize that the domestic firm may improve its competitive power vis-à-vis its foreign counterparts by learning within its existing line of technological development. A firm's ability to choose either to absorb foreign technology or to fellow existing independent lines of technological development, depends on its prior level of technological competence. Thus, domestic firms benefit from spillovers from FDI in accordance with their existing technological levels or their initial technology gaps. Two very different perspectives exist in the literature on this matter: on the one hand, it is argued, according to the advantages of the backwardness hypothesis, that the wider the technology gap, the greater the opportunity for domestic

firms to achieve higher level of productivity by learning from FDI (Findlay, 1978). On the other hand, it is asserted that a large technology gap lessens the domestic firms' ability to catch up with foreign rivals (Cantwell, 1989). Relying on this second strand of analysis, effective learning activities are then highly related to the existence of relatively small technology gaps. In other words, domestic firms with a low technological level are unlikely to experience positive spillovers and foreign firms in this case do not have any motivations to import more and newer technologies from mother companies, since technology imports are costly. An extensive empirical literature has been done in line with this argument, by among others Kokko at al. 1996, Glass and Saggi 1998, Girma et al. 1999, and Buckley et al. 2002.

Our model developed here assumes that not only domestic firms with relatively high technological capacity gain benefits from FDI, but even low technology firms may experience some spillover benefits – in that they may gain a lot from personnel assistance drawn from the movement of the "MNCs' labor". Low technology firms have a great interest in turning their learning efforts to the recruitment of "MNCs' personnel" so as to get some assistance in imitating foreign technologies and then raising their productivity level.[2] As Mody (1989) states, relatively high technology firms are very likely to benefit from spillovers through demonstration and/or competition effects, while domestic firms with relatively moderate technological competence, which are not in a position to compete fiercely with foreign firms, gain a lot from other forms of spillovers such as worker mobility, since this channel provides a (technical, managerial, etc.) assistance which can help domestic firms to better understand and implement foreign technology. Then, only firms with very low technological competence, to a point that they are not capable of reaping profits via any of the spillover channels, enter into a process of cumulative decline and eventually leave the market.

Given this assumption, we assume that FDI spillovers are determined by the interaction between the channels by which they occur and the technological characteristics of the recipient host firms. Thereby, spillovers increase with the technology gap up to a certain critical level, beyond which technological competence of domestic firms will be so low that they will generally, not by any means, be able to efficiently exploit the technological opportunities arising from foreign MNC presence.[3] Obviously, diverse factors intervene in the determination of this critical level, viz. the capacity of domestic firms in attracting the "MNCs' labor" by giving them a mark-up superior to the benefit level, the level of complexity of foreign technologies, the appropriability regime, etc.

[2]Of course domestic firms with high and mid technological levels may also use the technique of worker mobility to gain access to foreign knowledge. But these kinds of firms tend rather to make use of other spillover channels from which they have the opportunity to gain benefits with less cost.

[3]We assume that spillovers to some extent increase with technology gap because spillovers from worker mobility which are very likely to be used by relatively low technological firms tend to be higher than through demonstration effects, since the worker mobility channel leads to substantial improvement of the productivity of those firms by transferring not only public technology but also the tacit element – this argument has been described in detail in the previous section.

1.3. Geographical proximity and spillovers. The binomial spillover channels/technological conditions of domestic firms already contain most of the characteristic of our model. Nonetheless, a further important element of it is the presence of geographical proximity between domestic and foreign firms, in that spillover benefits are more pronounced in locations where domestic firms are close to their foreign counterparts, so that as geographic distance increases, spillovers decrease – i.e. learning is highly localized (Yildizoglu and Jonard, 1999).

In fact, firms in the same location tend to follow the same technological trajectory; wherein technological disparities are expected to be smaller, since MNCs are more likely to establish affiliates in more competitive regions (Dunning, 1992). Then, domestic firms within the same location are more likely to benefit from spillovers than other, more distant ones. Furthermore, given that labor turnover and demonstration are among the important channels for spillovers, domestic firms located nearby may be more likely to benefit from foreign affiliates (also called target firms in this case) than other ones, since knowledge is generated and transmitted more efficiently via local proximity and its transmission costs are assumed to increase with distance (Audretsch, 1998). Thus, spillover benefits tend to be captured first by neighboring domestic firms, and perhaps gradually spread to other, faraway ones.

This characteristic of our model fits nicely with some of the most recent empirical studies of spillover effects. Aitken and Harrison (1999), for instance, found that regional foreign investment has positive and significant impact on the productivity of Venezuelan firms, while spillover effects are negative with industrial foreign investment. Similarly, Girma and Walkelin (2002), and Liu and Wei (2006) have shown the importance of geographical proximity in assessing the indirect impact of FDI, in that they concluded that domestic firms gain from the presence of foreign firms in the region, but loose out if the firms are located in different regions.

When spillover effects are measured at a national level, these regional benefits might not be observed if they are too small to offset the overall negative impact across all regions. To test for the possibility that spillovers occurred at the regional level, existing studies included regional foreign share and that from outside the region in their specifications rather than sectorial foreign share. Regional foreign share is measured by the share of "employment, value-added or capital" in an industry within a region employed by foreign firms.[4]

2. The model

In the model developed here, we embed the question of spillovers examined in Perez' work (1998), wherein he explained the process of FDI spillovers by means of a dynamic interaction between foreign and domestic firms at the technological level, into a larger one by allowing for different

[4]We would like to note that we make use of this measure of regional spillovers when we test these effects for Swiss case (chapter 9).

mechanisms by which domestic firms benefit from FDI. In fact, to protect its market share, a domestic firm may choose to innovate or imitate foreign technologies according to its technological competence. Successful learning then drives domestic firms to improve their competitive power relative to their foreign counterparts. Such improvement is likely to be higher when foreign and domestic firms are neighbors. More specifically, the model developed in what follows embodies the following properties:

(i) The size and the extent of spillovers vary according the mechanism by which they occur, which in turn depends on the level of technological capacity of domestic firms,
(ii) Besides technological conditions, a domestic firm may acquire the best foreign practice technology via the recruitment of MNC's workers according to its capacity in attracting the "MNCs' labor" by giving them a mark-up superior to the benefit level,
(iii) Domestic firms that are located near foreign firms may be more likely to benefit from spillovers than other, more distant firms; as geographic distance increases, spillovers decrease.
(iv) A firm's market share grows in relation to with its technological level relative to the other firms operating in the market,
(v) Technology imports by foreign firms are inversely related to the existing technology gap and to its capacity to protect its technological advantages from labor turnover,
(vi) The dimension of the market grows with the national income according to a "Keynesian" mechanism of demand formation.

2.1. The selection environment. The model developed here is of an industry in which a number (n) of firms produce a single homogeneous product. Each firm undertakes two activities, namely learning (via innovation and imitation) and production; labor is the only input in both activities.

The basic framework of the model is taken from Dosi and Fabiani (1994). Let dots stand for growth rates, f_i be the market share of firm i, E_i its absolute competitiveness, and $\bar{E}$ the average competitiveness in the market. Then, the dynamics of the market share of firm i depends on its relative competitiveness as follows

$$\dot{f}_i(t, t+1) = a\left[\frac{E_i(t)}{\bar{E}(t)} - 1\right] f_i(t), \tag{2.1}$$

with

$$f_i(t) = \frac{Y_i(t)}{Y(t)}, \tag{2.2}$$

$$E_i(t) = \frac{1}{p_i(t)}, \tag{2.3}$$

$$\bar{E}(t) = \sum_i f_i(t) E_i(t), \tag{2.4}$$

where p_i is the price charged by the i-th firm, Y_i its output (= income), and Y the total output.

This replicator dynamic (equation (2.1)) associated with market selection entails the coexistence of firms characterized by diverse levels of efficiency and various behavioral rules. The parameter a represents market selectiveness, in that firms whose behavior resulted in highly competitive power will grow (in terms of market share) and others will loose the race, eventually forcing them to leave the market. Firms consequently exit the industry when

$$f_i < f_{\min}. \tag{2.5}$$

Given the equations (2.1) and (2.2) and assuming the existence of two groups of firms – foreign and domestic – interacting with each other in the industry, the output dynamic of the domestic firm is

$$\dot{Y}_{iD}\left(t, t+1\right) = a\left[\frac{E_{iD}\left(t\right)}{\bar{E}\left(t\right)} - 1\right]\frac{Y_{iD}(t)}{Y(t)}Y\left(t+1\right) + \frac{Y_{iD}(t)}{Y(t)}\dot{Y}\left(t, t+1\right), \tag{2.6}$$

While the output dynamic of foreign firm is determined by its relative competitiveness as well as the flows of new FDI, measured in terms of the extra investment available to employ new domestic workers ($N_i^{FDI}(t) = \frac{FDI_i(t)}{(w_{iF}(t)+b_i(t))}$); where b, as we shall see later, refers to the non-wage compensation (benefit) the foreign firm chooses in order to minimize the movement of its labor.

$$\begin{aligned}\dot{Y}_{i_F}\left(t, t+1\right) &= a\left[\frac{E_{i_F}\left(t\right)}{\bar{E}\left(t\right)} - 1\right]\frac{Y_{i_F}(t)}{Y(t)}Y\left(t+1\right) + \frac{Y_{iF}(t)}{Y(t)}\dot{Y}(t, t+1) \\ &\quad + N_i^{FDI}(t+1)\pi_{iF}(t+1)p_{iF}\left(t+1\right), \end{aligned} \tag{2.7}$$

where π is the real labor productivity and FDI is endogenously determined as follows

$$FDI_i\left(t+1\right) = \kappa_i Y_{i_F}(t). \tag{2.8}$$

where κ_i depends on the existing technology gap between foreign firm and domestic leader ($Gap_i^{'}(t) = \pi_{iF}(t)/\pi_{iD}^{*}(t)$; the star denotes the foreign leader) as

$$\kappa_i(t) = \exp(-Gap_i^{'}(t)). \tag{2.9}$$

Pricing is based on mark-up procedure

$$p_i\left(t\right) = \frac{w_i(t)}{\pi_i(t)}\left(1+\rho\right), \tag{2.10}$$

where w is the nominal wage and, for the sake of simplicity, we take ($w_{iD} = w_{iF}$), ρ for the mark-up.

Workers N employed in both production and learning (innovating and imitating activities)[5] use all their wages received at time t to buy goods in the following period $(t+1)$. Thus, total demand which is equal to national income $Y(t)$ is given by

$$Y\left(t+1\right)=\sum_{i}w_{i}(t)N_{i}(t). \tag{2.11}$$

2.2. Innovating and imitating activities. To face the foreign competition, domestic firms have to improve their competitive power by either innovating or imitating foreign technologies. Then, spillovers emerge as learning activities succeed in increasing the firm's productivity. However, performing any learning activity depends broadly upon the technological capacity of the corresponding firm – here, the technology gap between domestic and foreign firms is taken as a proxy of technological capacity. As the technology gap increases, spillovers increase up to a certain critical value and thereafter turn down. Then, in similar way to Perez' (1998)formulation, the productivity of the domestic firm is determined by the number of domestic employees engaged in learning activities $N_{D}^{Learning}$ and its initial technology gap is given by

$$\frac{\dot{\pi}_{iD}\left(t,t+1\right)}{\pi_{iD}(t)}=\nu_{1}+\lambda_{0i}\left[1-\exp(-\mu_{1}N_{iD}^{Learning}(t))\right]\frac{Gap_{i}(t)}{\exp(\lambda_{1}Gap_{i}(t))}, \tag{2.12}$$

where in this case the technology gap is defined as the ratio between labor productivity in foreign leader and the domestic firm: $Gap_{i}(t)=\pi_{iF}^{*}(t)/\pi_{iD}(t)$; where the star denotes the domestic leader.

If the technology gap is too small, in that the productivity of the domestic firm is greater than or equal to the productivity of the best practice technology of foreign firms, then the domestic firm has no interest in imitation and vice versa. Given that N_{D}^{inn} and N_{D}^{imi} denote, respectively, the number of domestic employees engaged in innovating and imitating activities, domestic learning is distributed as follows

$$N_{iD}^{Learning}(t)=\left\{\begin{array}{ll} N_{iD}^{inn}(t) & \text{if } \pi_{iD}(t)\geqslant\pi_{iF}^{*}(t) \\ N_{iD}^{imi}(t) & \text{if } \pi_{iD}(t)<\pi_{iF}^{*}(t) \end{array}\right\}, \tag{2.13}$$

As previously noted, the domestic firm may choose to acquire the best foreign practice technology via either the demonstration mechanism or the recruitment of the "MNCs' labor", or both.[6]

$$N_{iD}^{imi}(t)=N_{iD}^{Dem}(t)+N_{iD}^{\mathrm{Re}\,c}(t), \tag{2.14}$$

In the case of foreign firms, productivity growth depends upon the decision to import new technologies from the mother company, which in turn

[5]The measurement of N is given by equation (2.32).

[6]As we will see in the subsection 2.4, this choice is determined by its existing technology gap.

depends on the existing technology gap between the foreign firm and the domestic leader $Gap^{'}$ and its capacity to protect its technological advantages from labor mobility b; and on the imitation of the best domestic practice technology (the so-called reverse spillovers).[7]

$$\frac{\dot{\pi}_{iF}(t,t+1)}{\pi_{iF}(t)} = \nu_2 + \lambda_{2i}\left[1-\exp(-\mu_2 N_{iF}^{imi}(t))\right]\frac{1/Gap_i^{'}(t)}{\exp[\lambda_3(1/Gap_i^{'}(t))]} + \lambda_4 \exp(-(Gap_i^{'}(t)), \quad (2.15)$$

where the benefit b is determined as

$$b(t) = 1 - \exp(-Gap_i^{'}(t)). \quad (2.16)$$

2.3. Localized learning. Learning tends to occur within firms' neighborhoods, that is, for example, a successful imitative draw of firm i stems mostly from the acquisition of the best practice technology in its neighborhood $V_i(\iota)$[8]

$$V_i(\iota) = \{j \mid d(i,j) \leqslant \iota\}, \quad (2.17)$$

where $d(i,j)$ represents the distance between firm i and its neighbors, and equals to

$$d(i,j) = ((x_i - x_j)^2 + (y_i - y_j)^2)^{\frac{1}{2}}, \quad (2.18)$$

where the pair of coordinates (x_i,y_i) represents the horizontal and the vertical location of the corresponding firm i. As shown by figure 5.1, which depicts the interaction structure for a set of 24 firms, the neighborhood of dimension 1 (ι= 1) of firm i with (x_i,y_i) = (3,3) is represented by the circle frame.

As λ_{0i} and λ_{2i} in previous section refer respectively to the size of spillover benefits of domestic and foreign firms, then they depend broadly upon the distance between these firms and the corresponding target ones. Relatedly, in the case of the domestic firm

$$\lambda_{0i} = 1 - \log(\delta_i d(i,j^*)), \quad (2.19)$$

and for the foreign firm

$$\lambda_{2i} = 1 - \log(\delta_i d(i,j^*)), \quad (2.20)$$

[7]Our model allows for two-way- spillover effects (from and to MNC).

[8]Localized learning formal presentation is based on Yildizoglu and Jonard (1999).

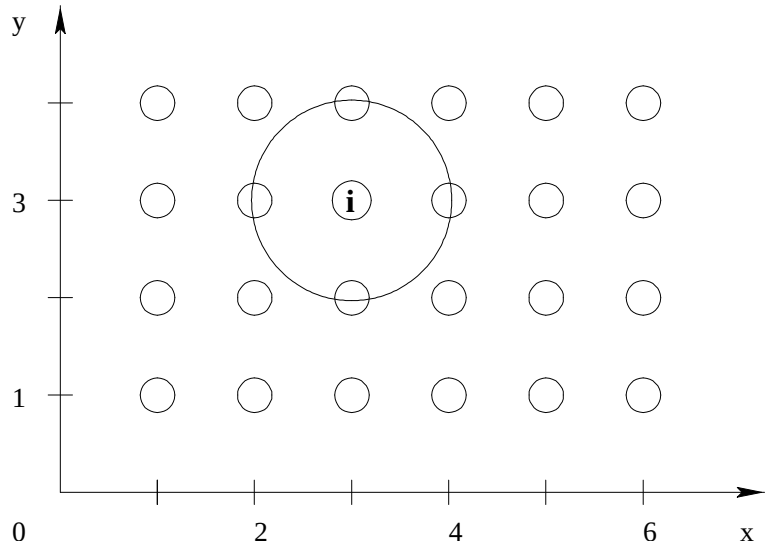

FIGURE 5.1. The neighborhood of firm i (3,3) for ι= 1. The pair of coordinates (x,y) represents the horizontal and the vertical location of the firms represented by ◯.

2.4. Labor market dynamics. The firm's investment in learning (RD) is proportional to its previous-period output since

$$RD_i\left(t+1\right)=\eta Y_i\left(t\right). \tag{2.21}$$

The firm's number of workers in productive activities N_i^P is defined by

$$N_i^P(t)=\frac{Y_i(t)}{p_i\left(t\right)\pi_i(t)}. \tag{2.22}$$

Regarding domestic firms, if the technology gap is too small, all their R&D resources are devoted to innovative activities

$$N_{iD}^{inn}(t)=\frac{RD_i(t)}{w_{iD}(t)}. \tag{2.23}$$

As concerns the foreign firm, all R&D resources are assumed to be devoted to imitating activities, independently of technology transfer mechanisms

$$N_{iF}^{imi}(t)=\frac{RD_i(t)}{w_{iF}(t)}. \tag{2.24}$$

Imitative learning of the domestic firm is proportional to the R&D resources devoted to both the imitation of the technology drawn from the demonstration process and recruitment of the "MNCs' labor" when some additional personnel assistance is required for a successful imitative draw

$$N_{iD}^{imi}(t) = \frac{\gamma_{iD} RD_{iD}(t)}{w_{iD}(t)} + \frac{(1-\gamma_{iD}) RD_{iD}(t)}{w_{iD}(t)(1+m_i(t))}, \tag{2.25}$$

when γ and $(1-\gamma)$ are respectively the fractions of the firm's workforce engaged in the adaptation and the imitation of foreign technology acquired through demonstration effects (N^{Dem}) and by means of worker mobility ($N^{\mathrm{Re}\,c}$). The domestic firm may choose to acquire the foreign best practice technology via either the demonstration mechanism or the recruitment of the "MNCs' labor", or both, according to its existing technology gap. γ is then a function of the technology gap, that is, as the gap increases, γ declines and domestic learning efforts are more devoted to the recruitment of the "MNCs' labor" to gain from personnel assistance

$$\gamma_{iD}(t) = \exp(-Gap_i(t)). \tag{2.26}$$

In addition, the fraction of employees engaged in the imitation of the technology drawn from the recruitment of the "MNCs' labor" depends on $(\Gamma(t) = \frac{m(t)}{b(t)})$, the ratio between the mark-up (m) the domestic firm attempts to pay to acquire the "MNCs' labor" and the benefit level the foreign firm pays over wages to protect their technological advantages from labor turnover. Obviously, the domestic firm attempts to recruit the "MNCs' labor" by choosing a mark-up superior to the benefit level

$$N_{iD}^{\mathrm{Re}\,c}(t) = \left\{ \begin{array}{ll} \frac{(1-\gamma_{iD}) RD_{iD}(t)}{w_{iD}(t)(1+m_i(t))} & \text{if } \Gamma_{iD}(t) \geqslant 1 \\ 0 & \text{if } \Gamma_{iD}(t) < 1 \end{array} \right\}, \tag{2.27}$$

and

$$m_i(t) = \sigma_i Gap_i(t). \tag{2.28}$$

The wage dynamic is the same for both foreign and domestic firms and is driven by labor productivity growth $(\dot{\bar{\pi}})$, consumer price changes $(\dot{\bar{p}})$, and changes in the levels of employment $(\dot{N})$

$$\dot{w}_i(t, t+1) = \upsilon_1 \dot{\bar{\pi}}(t-1, t) + \upsilon_2 \dot{\bar{p}}(t-1, t) + \upsilon_3 \dot{N}(t-1, t), \tag{2.29}$$

where

$$\bar{\pi} = \sum_i f_i \pi_i, \tag{2.30}$$

$$\bar{p} = \sum_i f_{ii} p_i, \tag{2.31}$$

$$N = \sum_i (N_i^P + N_i^{Learning} + N_i^{FDI}). \tag{2.32}$$

3. Conclusions

In this chapter we have developed an evolutionary model of spillovers which differs from previous ones presented in chapter 2 concerning three main points. First, it attempts to offer a more comprehensive picture of FDI spillovers by distinguishing these effects according to their diverse channels, viz. the effects of the increase of competition, the effects of demonstration, and the effects of worker mobility. It argues that the different channels of spillover benefits lead to different amounts of benefits since, inter alia, the amount and nature of the technologies transferred from foreign to domestic firms depend broadly on the mechanism by which they are transmitted.

Second, it hypothesizes that the size and the extent of such spillovers depend largely upon the interaction between the mechanisms by which they occur and the existing technological levels of domestic firms, in that domestic firms may improve their competitive power by either innovating or imitating foreign technologies depending on their existing technology gaps relative to foreign affiliates and only firms with very low technological capacity, to a point that they are not capable of reaping profits via any of the spillover channels, enter into a process of cumulative decline and eventually leave the market. And thirdly, it assumes that geographical proximity is an important element in determining the size and the extent of spillovers, in that spillovers are more pronounced in locations where domestic firms are close to foreign affiliates, so that as geographic distance increases, spillovers decrease – i.e. learning is highly localized.

To explore the outcome of our spillover model, we use a simulation technique. The following chapter is devoted to presenting this technique and discussing the simulation results we obtain by way of computer implementations.

CHAPTER 6

Simulation results

In this chapter we report and analyze the results of a simulation experiment using our spillover model developed in the previous chapter. This experiment is an exploration of the influence of learning activities, technological characteristics, and regional proximity on the productivity performance of domestic firms in terms of spillover benefits. Given the complexity of the dynamics defined by the equations of the model, we use simulation techniques to explore its outcome. The set of differential equations is solved using the language for simulation models named "the laboratory for simulation development (Lsd)".[1] Each simulation counts 1500 iterations, so that the trend of the model tends to converge towards a lasting quasi-stationary state. The case considered is of one industry. Firms within this industry are divided into foreign and domestic in which each one undertakes both learning and productive activities.

The remainder of this chapter is structured as follows. We discuss in the first two sections the results obtained by way of computer implementation and in section 3 the policy implications. Section 1 comments on the relationship between spillover effects and the interaction between spillover channels and technology gaps, while, section 2 will make explicit the relationship between regional proximity and spillovers.

1. On the role of the interaction between spillover channels and technological capacities

As have been previously outlined, our model developed in chapter 5 suggests that productivity spillovers are measured through different factors. Simulation results reported in this section are used to assess the influence of learning activities and technology gaps on the size and the extent of spillovers. We use four indicators to observe the number and the nature of these results, viz. the domestic firms' productivities, their market shares, their technology gaps, and the number of their learning employees.

Figure 6.1 plots the relationship between the initial technology gap and the dynamic of domestic productivity. The simulation results are drawn from an industry of thirteen domestic firms with diverse initial technology gaps and two foreign affiliates.[2] On the horizontal axis of the figure, the different values of the initial technology gap are depicted, and on the vertical

[1] It is a software developed by Marco Valente as part of his PhD firstly at IIASA and then at Aalborg University (Valente, 1999).

[2] Particular numerical values used in this simulation experiment are given in appendix 4.

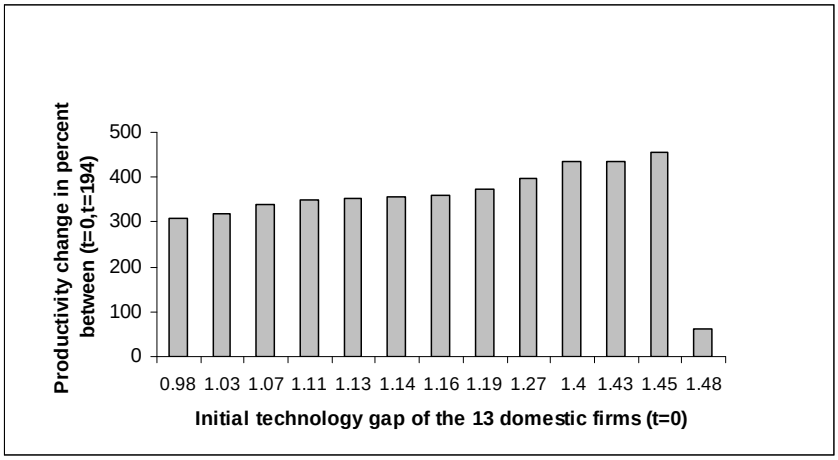

FIGURE 6.1. Simulation results: The percentage change in productivity of the 13 domestic firms over their initial technology gaps. The numbers from 0.98 to 1.48 are the values of initial technology gaps of these domestic firms.

axis, there are bins for the observed values of the domestic firm's productivity change. Two conclusions emerge from this figure. First, locations characterized by high, mid, and even relatively low prior levels of technological development – initial *Gap* between 0.98 and 1.45 – benefit from the FDI inflows in terms of productivity growth, while locations characterized by very low technological competence are not able to exploit the technological opportunities arising from foreign presence. Second, the extent of productivity spillovers grows with initial technology gaps up to a certain critical level (here, $Gap_{t=0} = 1.45$), thereafter spillovers are wiped out as domestic firms couldn't face foreign competition and then loose their market shares. The results obtained seem consistent with Perez's analysis.

Figure 6.2 plots the relationship between initial technology gaps and the dynamic of domestic technology gaps, using the same firms as in figure 6.1. Likewise, an increasing process of catching up by domestic firms emerges up to $Gap_{t=0}$ =1.45, which subsequently changes into a rapid process of falling behind.

These observations point to a conclusion which can be summarized in the following proposition:

PROPOSITION 1. *the greater spillovers are , the wider the technology gap up to a certain critical level, thereafter absorptive capacity of domestic firms declines.*

In what follows and for the sake of simplicity, we confine our sample to six firms in which we keep the same foreign firms and the four domestic firms considered as representative of the diverse technological categories of the industry[3]. Figures 6.3, 6.4, 6.5, and 6.6 resume the learning activities

[3]Particular numerical initial values used in this kind of simulation experiment are also given in appendix 4.

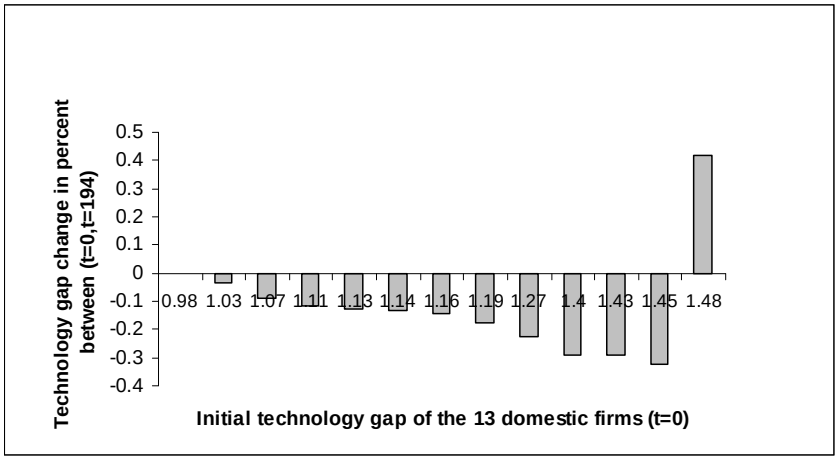

FIGURE 6.2. Simulation results: The percentage change in technology gaps of the 13 domestic firms over their initial gaps. The numbers from 0.98 to 1.48 are the values of initial technology gaps of these domestic firms.

undertaken by those domestic firms to improve their competitive power vis-à-vis their foreign counterparts, while figure 6.8 reports the effects of those activities on the catching up processes of the four domestic firms.

Figure 6.3 depicts the market shares of domestic and foreign firms over a period of 1500 "years". Firm D1, whose initial technology gap is less than 1, does not need, at least in the beginning of the period, to learn from foreign technologies to maintain its market share (figure 6.4). Instead, this firm benefits from foreign presence via competition effects as the competitive pressure generated by the presence of foreign firms induces it to more efficiently use its existing technology by mainly learning within its existing line of technological development.[4] Doing so, it succeeds in maintaining its competitive power and remains the leader of the industry. Firm D2, whose initial technology gap is slightly greater than one, adopts the best foreign technology as soon as it is no longer competitive to improve its technological competence. As shown in figure 6.5, this firm uses to a great extent the technique of demonstration to imitate foreign technology. Indeed, since this firm is not far behind the technological frontier of the industry, it manages to fully exploit the technological opportunities merely using demonstration effects. Firm D3, which belongs to the low level of technological development group with a relatively high initial gap, also manages to recover its market share by imitating foreign technologies. However, this firm is not able to benefit from foreign affiliates via demonstration effects alone, rather, as given by figure 6.6, it gains a lot from worker mobility as this channel provides a (technical, managerial, etc.) assistance which can help it to better understand and implement the foreign technology. Firm D4 demonstrates

[4]Note that firm D1, as showing in 6.4, attempts to constantly observe at the best foreign technology and sometimes use it, if required.

the pitfalls of missing the boat by loosing its market share. This firm exerts a very low competitive pressure over foreign counterparts. The market selection process drives it out of the market, eroding its profitability and, hence, its investment in learning.

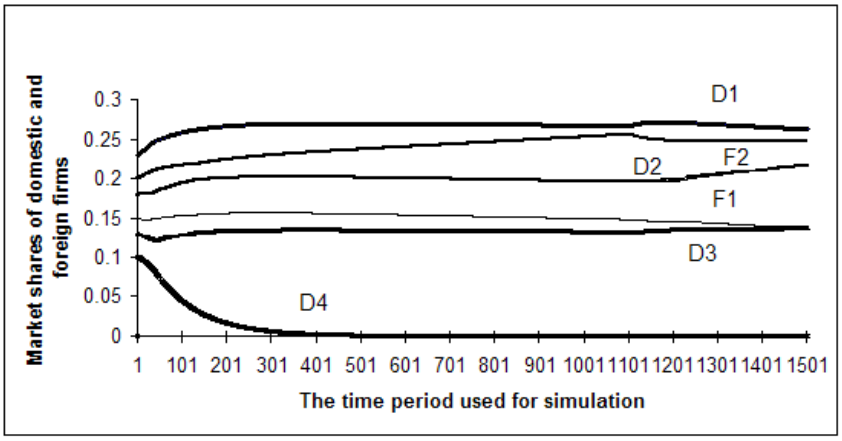

FIGURE 6.3. Simulation results: Market shares of the 4 domestic and 2 foreign firms over a period of 1500 years. D1, D2, D3, and D4 are domestic firms with, respectively, high, mid, low, and very low existing technological capacity. F1 and F2 are foreign firms with, respectively, low and high existing technological capacity.

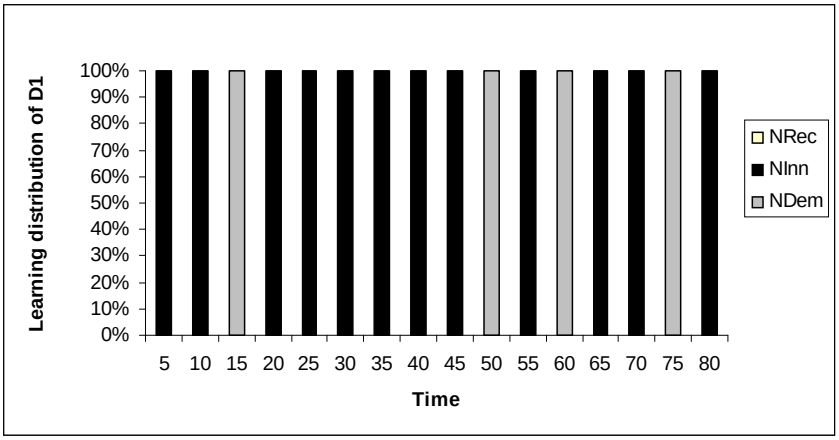

FIGURE 6.4. Simulation results: Learning distribution of the domestic firm D1 (the firm with high existing technological capacity). NInn refers to the share (in percent) of domestic employees engaged in innovating activities. NDem and NRec refer to the shares (in percent) of domestic employees engaged in imitating activities through, respectively demonstration and worker mobility techniques.

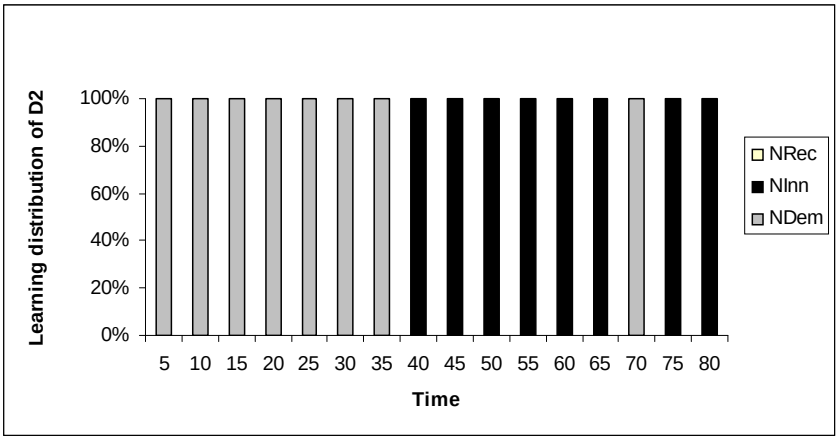

FIGURE 6.5. Simulation results: Learning distribution of the domestic firm D2 (the firm with mid existing technological capacity). NInn refers to the share (in percent) of domestic employees engaged in innovating activities. NDem and NRec refer to the shares (in percent) of domestic employees engaged in imitating activities through, respectively demonstration and worker mobility techniques.

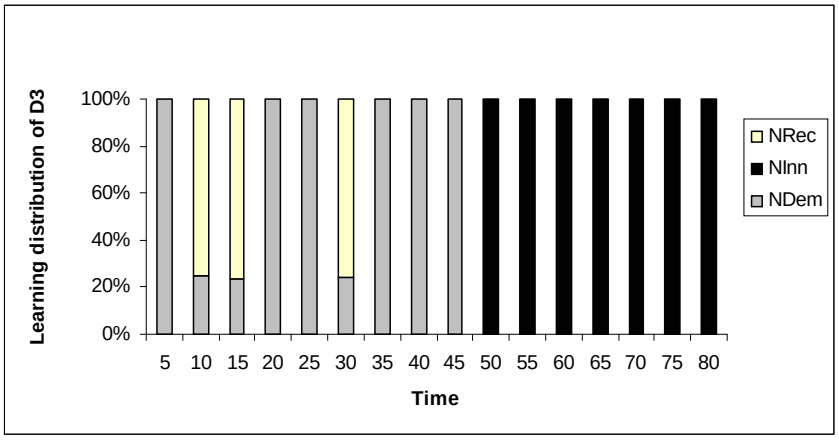

FIGURE 6.6. Simulation results: Learning distribution of the domestic firm D3 (the firm with low existing technological capacity). NInn refers to the share (in percent) of domestic employees engaged in innovating activities. NDem and NRec refer to the shares (in percent) of domestic employees engaged in imitating activities through, respectively demonstration and worker mobility techniques.

Regarding foreign firms, they also gained in terms of spillovers or "reverse spillovers" from their presence in the host country (figure 6.7). Foreign firm F1 for example, which experienced a large technology gap at $t =$

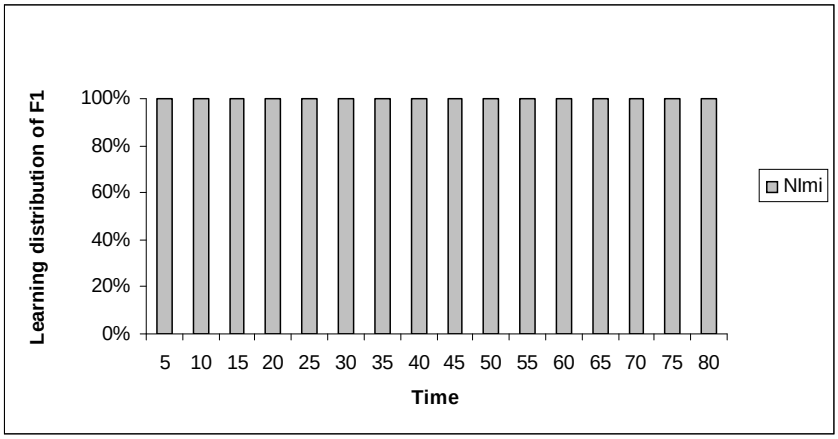

FIGURE 6.7. Simulation results: Learning distribution of the foreign firm F1 (the firm with low existing technological capacity). NImi refers to the share (in percent) of domestic employees engaged in imitating activities.

0, manages to guard its market share by imitating best domestic practice technologies (figure 6.7).

These observations point to a conclusion which can be summarized in proposition 2 as follows:

PROPOSITION 2. *High and mid technology firms tend to benefit from spillovers through competition and demonstration effects, respectively. While, domestic firms with relatively low technological competence gain a lot from worker mobility.*

For figure 6.8, we have plotted the dynamic of technology gaps of the four domestic firms over their initial technology gaps. A first glance at this figure shows that firm D3 benefits the most from foreign presence with reference to the catching up process, since worker mobility can lead to substantial improvements in its productivity by transferring not only public technology but also the tacit element that is unlikely to be transferred through informal contacts between firms. What clearly emerges from this figure is that the size and the extent of spillover benefits depend upon the mechanism by which they are transmitted as spillovers from imitation seem to be higher than from innovation effects, and similarly, spillovers via worker mobility are higher than via demonstration effects. Hence, the following proposition is obtained:

PROPOSITION 3. *The size of spillover benefit depends upon the mechanism by which they are transmitted. Spillovers via worker mobility for example are found to be higher than those through demonstration effects.*

2. On the role of geographical proximity

In order to study the pure effects of regional proximity on spillovers, we assume different values for the geographic distance between domestic and

foreign firms ($d_i \leq \iota = 1$ and $d_i > \iota = 1$)[5], where $\iota = 1$ corresponds to the regional frontier. The two figures describing the outcomes of this simulation experiment, figures 6.10 and 6.11, summarize the outcomes for the change from time 0 to 30 of the domestic firms' productivity gap as in figure 6.8, but respectively at the regional level ($d_i \leq \iota = 1$) and outside the region ($d_i > \iota = 1$). Figure 6.10 indicates that convergence becomes tighter as the rate of catching up on the whole becomes higher when regional proximity is taken into account. The results reported in figure 6.11 confirm this point, in that only firms D1 and D2, whose initial technology developments are at a comparable level to their foreign counterparts, maintain their competitive power and gain from the foreign presence even outside their regions. Conversely, firm D3, for example seems to be unable to compete with its foreign counterparts and enters into a process of cumulative decline, since the foreign knowledge this firm acquires becomes more costly when it is located faraway from its foreign counterpart. It is clear then that the greater the geographic distance is, the smaller the learning is and the smaller the spillover effects are. This result seems also to be confirmed for foreign firms, at least for foreign firm F1 (figures 6.9, 6.12 and 6.13). Hence, the following proposition is obtained:

PROPOSITION 4. *Spillover benefits are found to be more pronounced in locations where domestic firms are close to their foreign counterparts, so that as geographic distance decreases, spillovers increase.*

3. Concluding remarks

The results of the simulation experiments reported in this chapter are drawn from the evolutionary model of intra-industry spillovers we developed in the chapter 5. Our model suggests that the effects of foreign presence on the productivity development of domestic firms in terms of spillovers are likely to vary according to a number of indicators, namely, spillover channels, local characteristics, and regional proximity. In this respect, spillovers are assumed to be determined by the interaction between the channels by which they occur and the technological characteristics of the recipient host firms, in which relatively high/mid technology firms are highly likely to benefit from spillovers through demonstration and/or competition effects. While, domestic firms with relatively low technological competence may gain a lot from other forms of spillovers such as worker mobility. Moreover, the location of domestic firms that are near to their foreign counterparts creates room for a large amount of spillover benefits.

The simulation results seem to confirm our hypotheses and show that, on the one hand, high/mid technology firms benefit a lot from either competition or demonstration effects, while low technology firms manage to reap the benefit from foreign presence via the recruitment of the "MNCs' labor", in that this channel provides a (technical, managerial, etc.) assistance which can help domestic firms to successfully imitate foreign technology. On the other hand, spillover benefits are more pronounced in locations where

[5]These numerical values are given in appendix 2.

domestic firms are close to their foreign counterparts. These results also demonstrate that the size and extent of spillovers vary according to the mechanism by which they occur, spillovers via worker mobility, for example, are higher than through demonstration effects.

Our theoretical findings uphold to some extent host countries' actions to attract foreign investors because they expect spillover benefits for the productivity development of their domestic firms. However, as positive spillover effects from foreign entry are found to be determined by the ability and motivation of domestic firms to invest in absorptive capacity, we are in agreement with Blomström and Kokko (2003) that actions supporting learning and investment in domestic firms, raising their ability and motivation to invest in absorbing foreign technologies and skills, are also important in leveraging the potential benefits of spillovers. In addition, foreign firms might be established near their domestic counterparts, in particular, low technology firms, in order to better absorb foreign resources and then upgrade their technological competitiveness, given that those kind of firms largely use the worker mobility mechanism to get foreign knowledge, and this channel is costly. Its cost is assumed to increase with geographic distance.

Testing the theoretical findings underlying the above against empirical evidence would also be promising and of a great importance to policy-makers in leveraging the potential benefits of inward FDI spillovers. The next part of the thesis fits well with this purpose wherein Swiss data will be explored. We use both qualitative and quantitative analyses to examining spillovers in Switzerland.

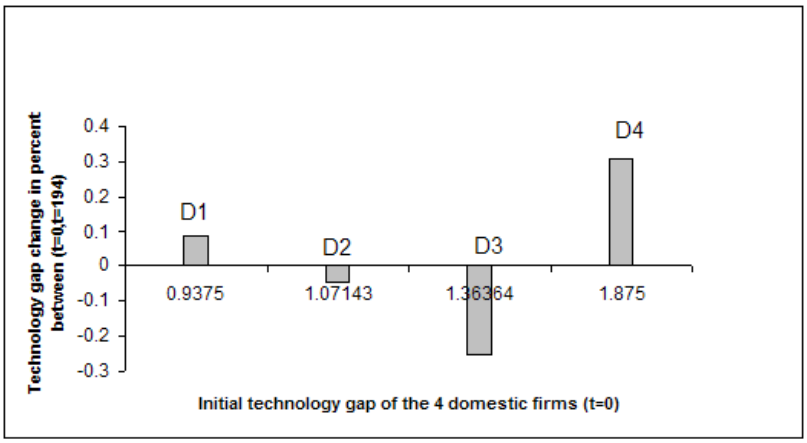

FIGURE 6.8. Simulation results: The percentage change between t=0 and t=194 in technology gaps of the 4 domestic firms over their initial gaps. The numbers from 0.9375 to 1.875 are the values of these initial gaps. D1, D2, D3, and D4 are domestic firms with, respectively, high, mid, low, and very low existing technological capacity.

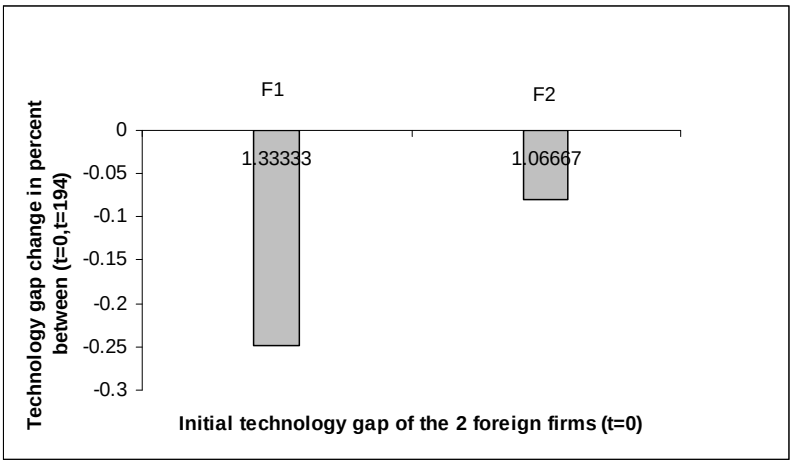

FIGURE 6.9. Simulation results: The percentage change between t=0 and t=194 in technology gaps of the 2 foreign firms over their initial gaps. The numbers 1.333 and 1.066 are the values of these initial gaps. F1 and F2 are foreign firms with, respectively, low and high existing technological capacity.

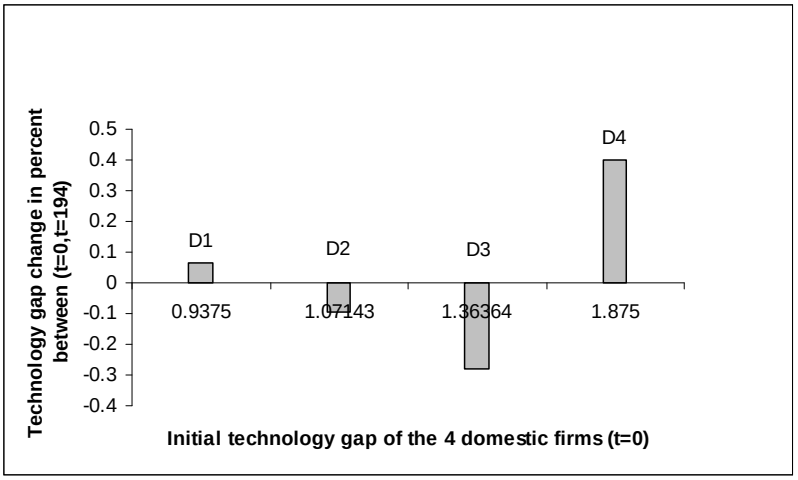

FIGURE 6.10. Simulation results: The percentage change between t=0 and t=194 in technology gaps of the 4 domestic firms over their initial gaps ($d_i \leq \iota = 1$). The numbers from 0.9375 to 1.875 are the values of these initial gaps. D1, D2, D3, and D4 are domestic firms with, respectively, high, mid, low, and very low existing technological capacity.

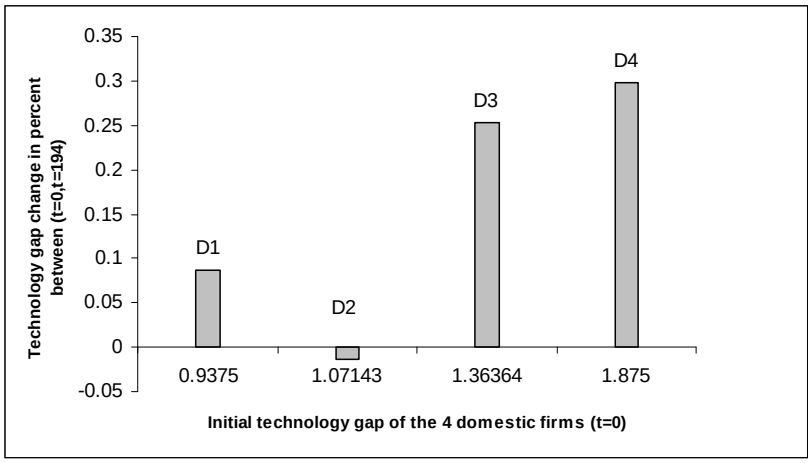

FIGURE 6.11. Simulation results: The percentage change between t=0 and t=194 in technology gaps of the 4 domestic firms over their initial gaps ($d_i > \iota = 1$). The numbers from 0.9375 to 1.875 are the values of these initial gaps. D1, D2, D3, and D4 are domestic firms with, respectively, high, mid, low, and very low existing technological capacity.

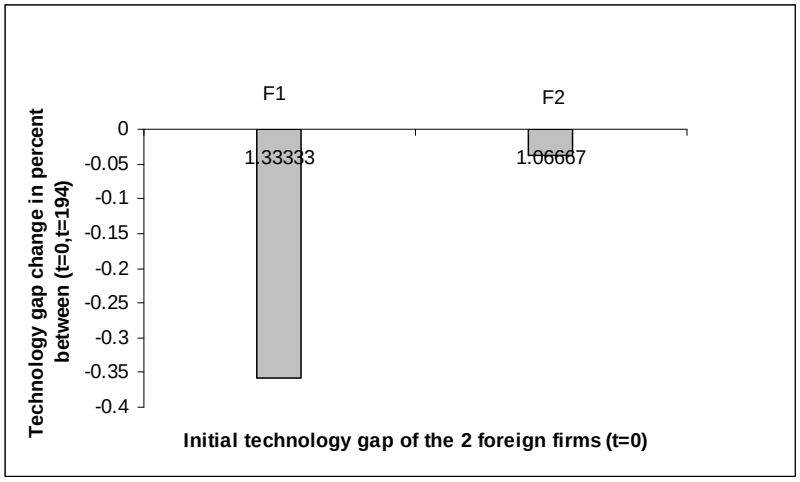

FIGURE 6.12. Simulation results: The percentage change between t=0 and t=194 in technology gaps of the 2 foreign firms over their initial gaps ($d_i \leq \iota = 1$). The numbers 1.333 and 1.066 are the values of these initial gaps. F1 and F2 are foreign firms with, respectively, low and high existing technological capacity.

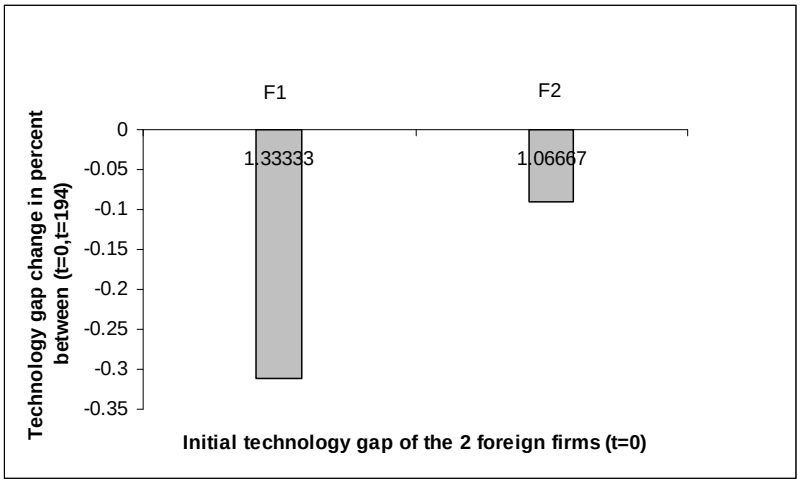

FIGURE 6.13. Simulation results: The percentage change between t=0 and t=194 in technology gaps of the 2 foreign firms over their initial gaps ($d_i > \iota = 1$). The numbers 1.333 and 1.066 are the values of these initial gaps. F1 and F2 are foreign firms with, respectively, low and high existing technological capacity.

Part 3

FDI Intra-Industry Spillover Effects in Switzerland

In part 2 of this thesis we developed an evolutionary model which offers a more comprehensive picture of FDI intra-industry spillovers by distinguishing these effects according to their diverse channels. It hypothesizes that the size and the extent of such spillovers depend upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. That is, high and mid technology firms tend to benefit from spillovers through competition and demonstration effects, respectively, while, domestic firms with relatively low technological competence may gain a lot from worker mobility. Our model further assumes that spillovers are more likely to occur in neighboring firms than between other more distant ones. The results of the simulation reported in chapter 6 seem to confirm the hypotheses of our model.

In this part of the thesis we attempt to test our hypotheses against the empirical evidence for the Swiss economy using both qualitative and quantitative analyses of data.[6] Switzerland is a particularly interesting example for this study given that it experiences increasing flows of inward FDI over time. It is regarded to have achieved competitive technological levels in many industries; MNCs tend to concentrate their activities in more dynamic and competitive industries. And Swiss government authorities (mostly at the cantonal level) are more and more active in attracting foreign MNCs.

Regarding qualitative analysis, we interviewed managers of 43 firms operating in Switzerland, divided into 30 domestic firms and 13 majority-owned foreign affiliates, of diverse industries from manufacturing and services/construction. The interview results are given in chapter 8. For the quantitative analysis, we tested the size and the extent of intra-industry spillovers at both the industrial and the regional levels according to the mechanisms by which they occur, the levels of technological capacity of domestic firms – expressed in terms of technology gaps, and the levels of their learning and investment efforts undertaken to absorb foreign knowledge measured by the level of investment expenditures in new equipment and training activities for product/process innovation. The regression analysis we discuss in chapter 9 makes use of a sample of 657 firms, derived from the Swiss institute for business cycle research "KOF" innovation activity surveys (2002 and 2005) and divided into 370 in manufacturing and 287 in services/construction.

The structure of this part is as follows. Following this introduction, chapter 7 analyzes data and descriptive statistics about FDI in Switzerland and the performance of domestic firms vis-à-vis foreign firms. Chapter 8 summarizes the results from a number of interviews conducted with Swiss and foreign firms. And, chapter 9 discusses the estimation results.

[6] To the best of our knowledge, this study is the first to explore the Swiss case.

CHAPTER 7

Data analysis

Switzerland has an open and welcoming attitude towards FDI (UNCTAD, 2006). Swiss government authorities, especially cantons, attempt to attract MNCs to Switzerland using substantial fiscal and financial incentives; favorable tax treatment is provided for many forms of foreign investment (Sermet, 2003).[1] Switzerland also has an excellent geographical location as it is in the center of Europe with political and monetary stability and a high quality infrastructure. It is the leading industrialized country after Israel, Sweden, Finland, and Japan in terms of R&D expenditures[2] (figure 9.1 in appendix 5). In 2004 the R&D expenditures are to some degree at the same level as (or even lower than) in 2000 for all the countries except Switzerland which experiences increased flows. These R&D efforts are markedly noticed in pharmaceuticals, the R&D sector,[3] and high technology instruments (figure 9.2 in appendix 5). A more detailed analysis of R&D expenditures across sectors, given by figures 9.3 and 9.4 in appendix 5, shows that apparel, energy/water, watches, electronics/instruments, vehicles, computer services/R&D, and other business services represent the main sectors investing in their own R&D within the period of 2000-2002.[4]

Such technological strengths and political interventions have largely contributed to an expansion of the flows of inward FDI in Switzerland.[5] The distribution of these flows both in Switzerland and in the world is examined in section 1. The performance of domestic firms vis-à-vis their foreign counterparts is analyzed in section 2, and the contribution of foreign firms to the development of human capital in Switzerland is discussed in section 3.

[1] Recently, after the failure to attract the American MNC "Amgen" to set up affiliate in Switzerland, Joseph Deiss "the head of economic department in Switzerland" claims that efforts should be gathered to reinforce the attractiveness of Switzerland on the part of foreign MNCs by developing clusters, essential to increasing the competitive power of the Swiss economy (Nussbaum, 2006).

[2] R&D is a key factor of economic competition. Firms cannot absorb outside knowledge unless they invest in their own R&D (Narula and Marin, 2003).

[3] This sector includes all firms giving R&D services for others active in R&D.

[4] In terms of innovation expenditures, figures 9.3 and 9.4 in appendix 5 demonstrate that vehicles, electronics/instruments, machinery, apparel, textiles, transport/communication, and computer services/R&D are the main investing sectors.

[5] As we shall see in the next section, the Swiss economy recorded sharp increases in inward FDI which in 2003, for example, surpassed outward FDI.

1. FDI distribution in the global economy and in Switzerland

This section examines, firstly, the distribution of FDI over all the world, secondly, the regional distribution of FDI in Switzerland, and, finally, the contribution of MNCs to Swiss economic activity (in terms of total sales and employment).

The global flows of inward FDI worldwide grew up in 2004 after a sharp decrease in previous years reaching 41% in 2001 (UNCTAD, 2005). As figure 7.1 shows, this growth reflects increased flows to developing countries and to South East Europe and the Commonwealth of Independent States (CIS). The difference between inflows of FDI to developed countries and developing countries is reduced to $147 billion – a significant narrowing of the gap compared with previous years, for example in 2000 it was $881 billion (UNCTAD, 2005).

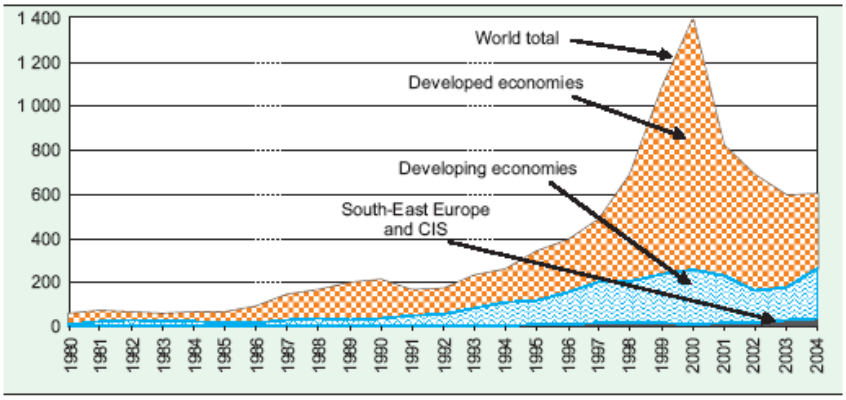

FIGURE 7.1. FDI inflows (in billions of dollars), global and by groups of economies, 1980-2004. *Source*: UNCTAD (2005).

Figure 7.2 shows that the United States was the major recipient country of FDI flows in 1996 and 2003 ahead of other OECD countries, although they experienced a large decrease in their flows between 1996 and 2003. Switzerland is one of the smaller European countries which, like Austria and Norway, recorded sharp increases in inward FDI in 2003 (OECD, 2004b); it is the sixth OECD country that sees increased flows in 2003, which even surpass those of outward investment (figure 7.3).

FDI in Switzerland is not equally distributed across regions; there is no spatial diffusion of international investments in Switzerland (Crevoisier and Roth, 2005). As shown by figure 7.4 there exist regions with inward or outward FDI or even both and others without any international investment. The Alpes for example are not internationalized, while the cantons of Vaud, Geneva, Zurich, Basel, Fribourg, and Ticino experience large inward investment which is above the national average. Crevoisier and Roth claim that the most internationalized regions correspond, to a large extent, to Switzerland's financial centres (Geneva, Lugano, Zurich and Basel) and

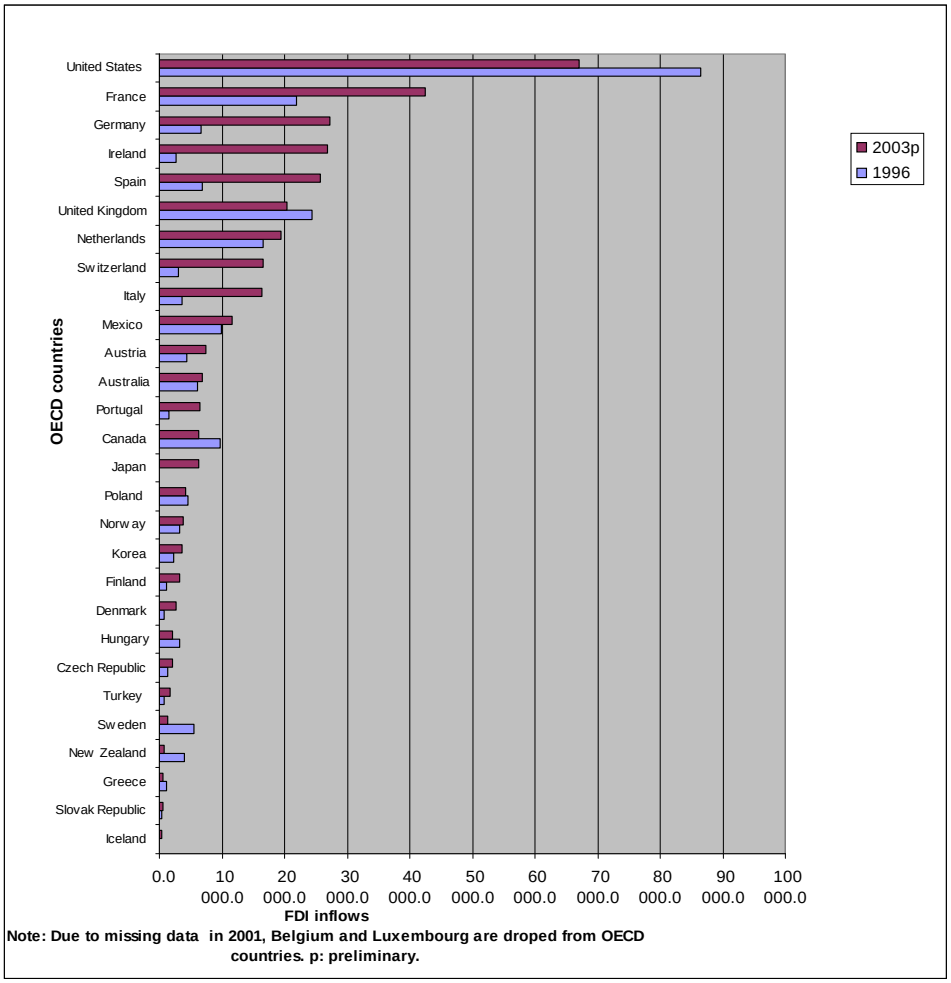

FIGURE 7.2. OECD direct investment from abroad: inflows (in millions of dollars). *Source*: OECD (2004a).

to traditionally industrial regions (eastern Switzerland and the arc of the Jura).

TABLE 7.1. FDI participation in manufacturing and services/construction in Switzerland: annual shares of foreign firms in sales and employment (percent)

Year	Total employment	Total sales	Number of foreign firms	Number of domestic firms	Total number of firms
2001	11.6	21.9	314	1992	2306
2004	13.8	20.3	316	1989	2305

Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

In what concerns the role of MNCs in Swiss economic activity, tables 7.1, 7.2 and 7.3 present a summary of MNCs' activity in total employment

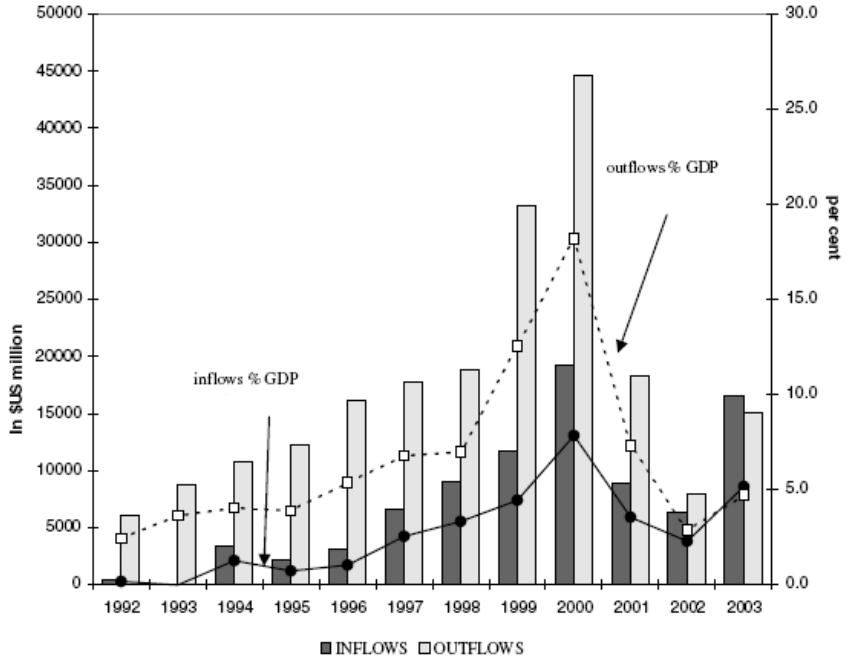

FIGURE 7.3. Direct investment flows in Switzerland. *Source*: OECD (2004a).

and sales. Information in these tables are based on the author's calculations of data derived from innovation activity surveys (2002 and 2005) of manufacturing and services/construction firms (domestic and majority-owned foreign), with at least 5 employees, conducted at the Swiss institute for business cycle research "KOF".[6] The firms' samples include 2306 firms – 314 majority-owned foreign affiliates – in 2001 and 2305 firms – 316 majority-owned foreign affiliates – in 2004.[7] All of the author's calculations are based on weighted data sets[8] so as to give a representative picture of the Swiss economy.[9]

As shown in table 7.1, the share of foreign investment in manufacturing and services/construction total employment accounted for 2001 is about 11.6 (21.9 in total sales). This share hides significant differences across sectors as shown in table 7.2, in that 84 percent (94.7 in sales) of computer and office equipment is foreign owned compared to only 2.5 percent (8.8 in sales) for printing and publishing. The foreign presence is also preeminent in among others paper, electrical machinery, transport equipment, R&D institutions, and computer services. In spite of the slight change of the

[6]Questionnaires can be downloaded from www.kof.ethz.ch (Industrieökonomik).

[7]Unfortunately, data for 2001 and 2004 are the most recently available ones.

[8]Except the calculations related to the number of firms.

[9]The weights are used to correct for the selection bias resulting from "unit" non-response and for the deviations of the sample structure from that of the underlying population.

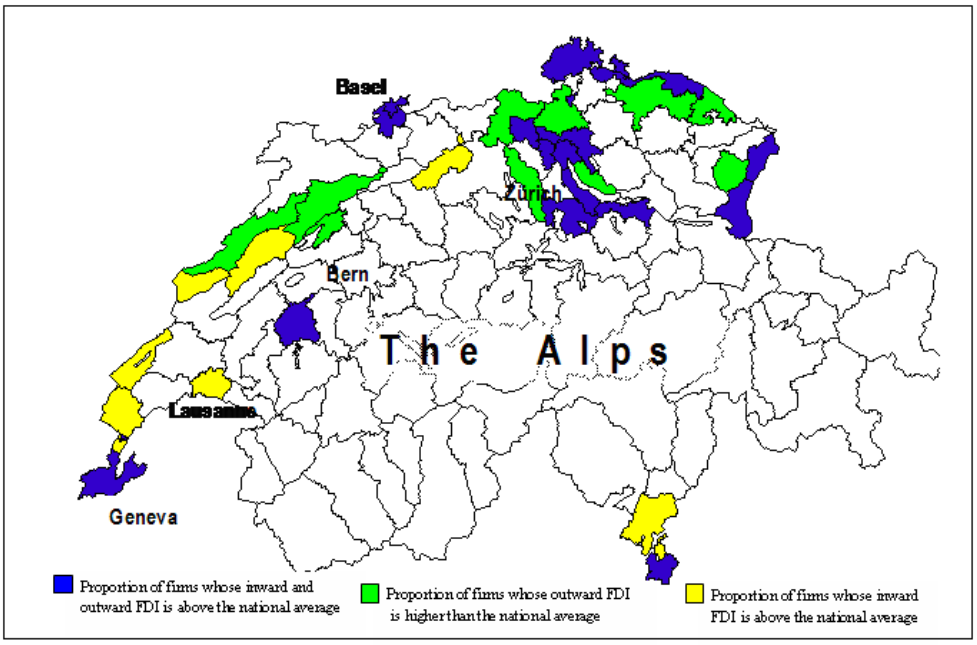

FIGURE 7.4. Regional distribution of FDI in Switzerland: specialisations of the regions as divided according to Spatial Mobility regions, in 2001 (location quotients). *Source*: Crevoisier and Roth (2005), Swiss Federal Statistical Office, Business Census 1995, 2001.

foreign employment and sales shares at the aggregate level from 2001 to 2004, there is a significant change in foreign share across sectors. That is 9 of the sectors recognize a substantial increase in foreign employment share (13 in foreign sales share), while in other sectors it falls by as much as 50 percent (insurance in terms of total sales; food, watches, computer and office equipment, retail trade, and computer services in terms of total sales and total employment).[10]

Table 7.3 illustrates the importance of FDI for regional development in Switzerland. It shows some variation in the share of foreign firms across regions[11] in 2001, markedly in total sales for which Ticino and the Lemanic region experienced the highest shares (49.58 and 38.8 respectively) while North West Switzerland had 10.4 percent and only 6.48 in Mittelland space in terms of employment.[12] From 2001 to 2004 foreign share recognizes a significant change across regions in which it increases substantially within

[10]Note that the change of foreign share in sectors from 2001 to 2004 may result, as we shall see later, from the substantial change these sectors experience in some Swiss regions relative to others.

[11]The regional repartition used in this thesis corresponds to the division used by the KOF institute.

[12]The difference between regions may be explained by large disparities betwen cantons in terms of tax treatment and financial incentives.

TABLE 7.2. FDI participation in manufacturing and services/construction in Switzerland: sectoral shares of foreign firms (percent)

Sector	Total employment		Total sales	
	2001	2004	2001	2004
Manufacturing				
Food	13.3	4.3	15	2.9
Textiles	13.8	14.9	16.5	13.6
Wood products	9.5	5.4	25.3	6.5
Paper	32.1	25	38.3	29
Printing and publishing	2.5	8.3	8.8	12.7
Chemicals	25	22.2	21.8	25.6
Pharmaceuticals	13.2	13	7.1	23.5
Plastics	20.6	23.7	29.1	32.4
Non-metal mineral products	16.9	11.3	15	13.4
Metal production	6.9	11.9	10.9	13.8
Metalworking	12.9	10	17.7	13.9
Machinery	28.9	22.9	32.4	21.3
Electrical machinery	26.4	49.7	31	59.3
Computer and office equipment	84	11.6	94.7	11.4
Communication equipment	15	40.1	13.5	54.1
Medical instruments	20.1	27.1	21.8	35.4
Watches	5.1	2.2	9	0.7
Transport equipment	33.2	24.8	43.9	23.2
Other manufacturing	15.9	4.4	21.7	8.1
Other industries				
Trading and maintenance of motor vehicles	9.3	18.2	32.9	46.2
Wholesale trade	23.5	20.6	31.5	40.7
Retail trade	9.4	4.5	17.8	8.3
Tourism	4.4	5.8	5.4	7.7
Transport	2.9	7.7	3.4	15.6
Banking	22.1	20.6	21.7	14.4
Insurance	6.7	4.8	10.9	0.7
Real estate and leasing	8	40.3	6.7	0.4
Computer services	27.1	19.6	31.7	27.4
R&D institutions	24.8	51.2	39.9	70
Other business services	7.8	4.7	25.1	69.5
Construction	4.7	5.3	6.4	9.9

Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

Mittelland space (about triple, passing to 16.2 percent in generating employment) while in regions such as Ticino it falls bellow 50 percent in terms of total sales despite its increase in employment.

Regarding sectors, in 2001 figure 7.5 shows that foreign share in wholesale trade, chemicals, machinery, and medical instruments was preeminent in the Lemanic region. Central Switzerland also holds large foreign share

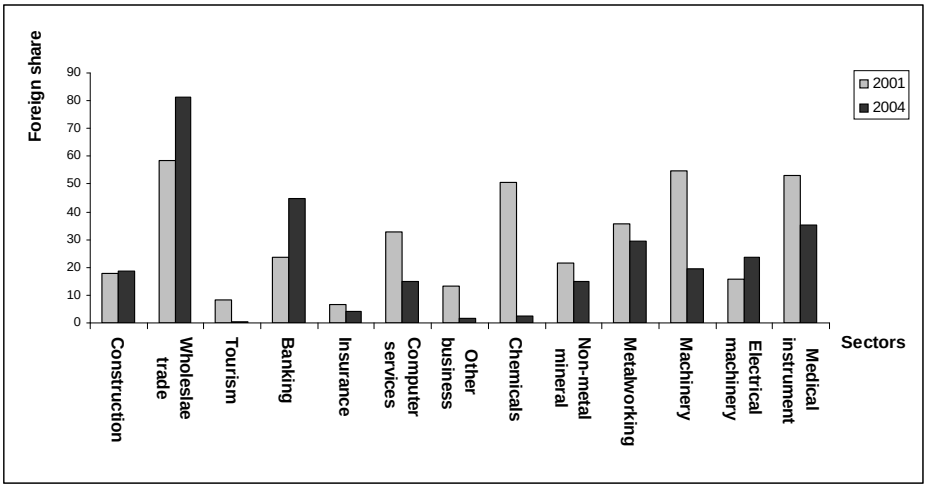

FIGURE 7.5. Percent share of foreign firms in total sales in the same sector and region "Lemanic region". Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

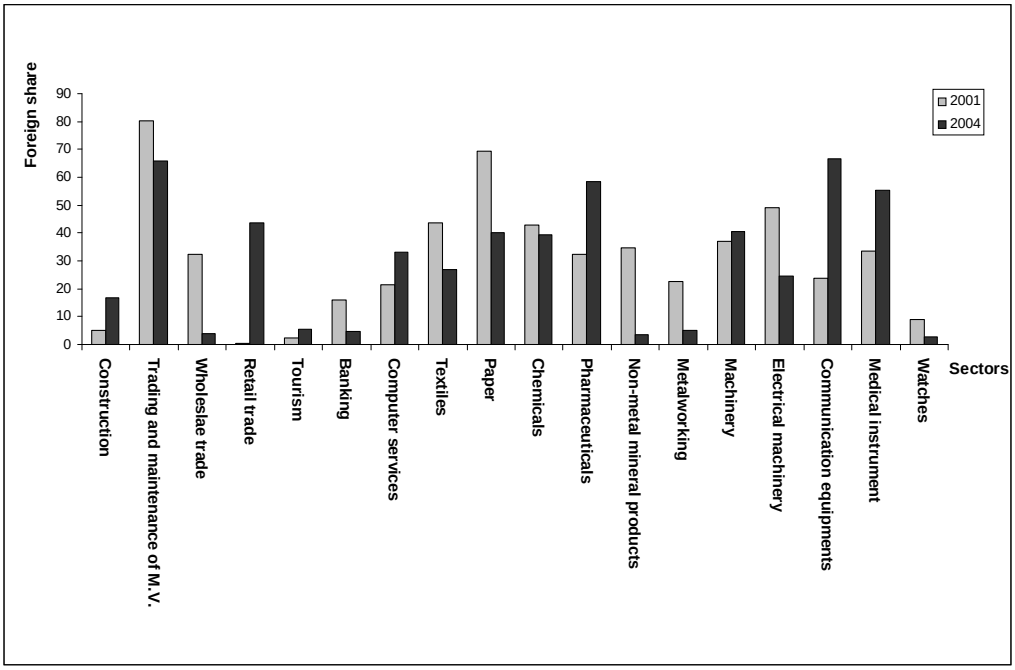

FIGURE 7.6. Percent share of foreign firms in total sales in the same sector and region "Mittelland space". Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

TABLE 7.3. FDI participation in manufacturing and services/construction in Switzerland by region: annual shares of foreign firms (percent)

Region	Total employment		Total sales		Number of foreign firms	
	2001	2004	2001	2004	2001	2004
Lemanic region[a]	17.36	9.8	38.8	35.3	12.8	10.55
Mittelland space[b]	6.48	16.2	13.4	19.57	10.26	10.3
North West Switzerland[c]	9.9	10.4	10.5	12.3	13	13.38
Zurich	14.9	13.95	20.4	21.3	13.5	15.3
Western Switzerland[d]	10.6	11.4	14.3	16.36	10.9	11.3
Central Switzerland[e]	11.9	9.15	19.3	15.98	10.8	12.35
Ticino	11.59	14.47	49.58	11.2	10.3	7.69

a: Lemanic region includes the cantons of Vaud, Valais, and Geneva.

b: Mittelland space includes the cantons of Bern, Fribourg, Jura, Neuchâtel, Solothurn.

c: North West Switzerland includes the cantons of Aargau, Basel-Stadt, and Basel-Landshaft.

d: Western Switzerland includes the cantons of Appenzell Ausserrhoden, Appenzell Innerrhoden, Glarus, Graubünden, Schaffhausen, St-Gallen, and Thurgau.

e: Central Switzerland includes the cantons of Lucerne, Nidwalden, Obwalden, Schwyz, Uri, and Zug.

Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing services/construction firms.

in chemicals and wholesale trade sectors as well as in plastics (figure 7.10). While foreign share in Mittelland space is preeminent in trading and maintenance of motor vehicles and paper (figure 7.6). Zurich recognizes large shares mainly in computer services, transport equipment, and banking (figure 7.8). Foreign firms dominate in R&D institutions within both North West and Western Switzerland[13] (figures 7.7 and 7.9), while in Ticino they are rather dominant in personal services and pharmaceuticals (figure 7.11). In 2004, the results change considerably across regions; some sectors recognize a decrease in foreign shares, mainly chemicals in the Lemanic region and Central Switzerland, computer services and food in Western Switzerland, and insurance and textiles in Zurich; whereas an increase in foreign shares is identified within, for example, Western Switzerland in mainly personal services, communication equipment, R&D institutions, transport, and tourism; also within Zurich in electrical machinery and other business services. Other sectors such as banking and pharmaceuticals witness, respectively, a decrease in foreign share within the boundaries of Zurich and Ticino and at the same time an increase within the Lemanic region and Mittelland space.

[13]North West Switzerland holds large foreign shares in others such as electrical machinery.

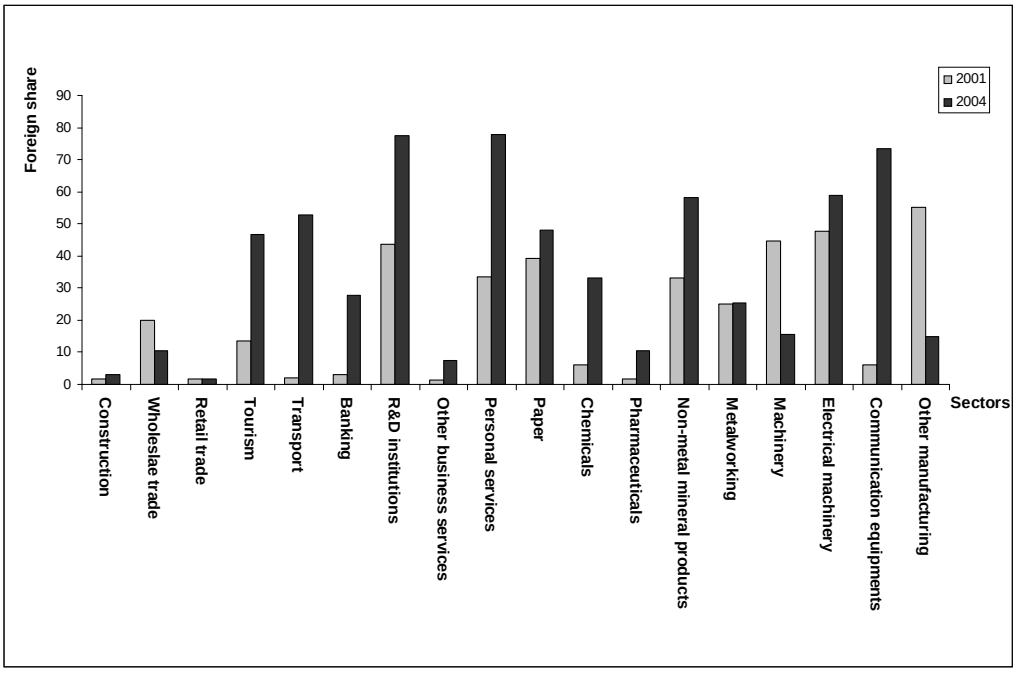

FIGURE 7.7. Percent share of foreign firms in total sales in the same sector and region "North West Switzerland". Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

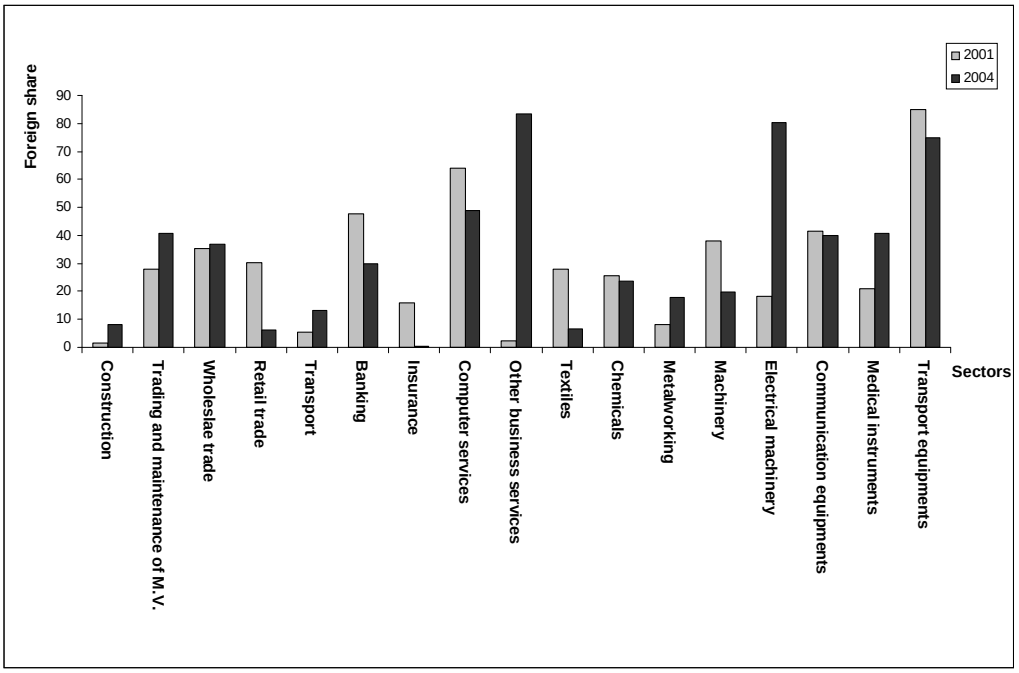

FIGURE 7.8. Percent share of foreign firms in total sales in the same sector and region "Zurich". Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

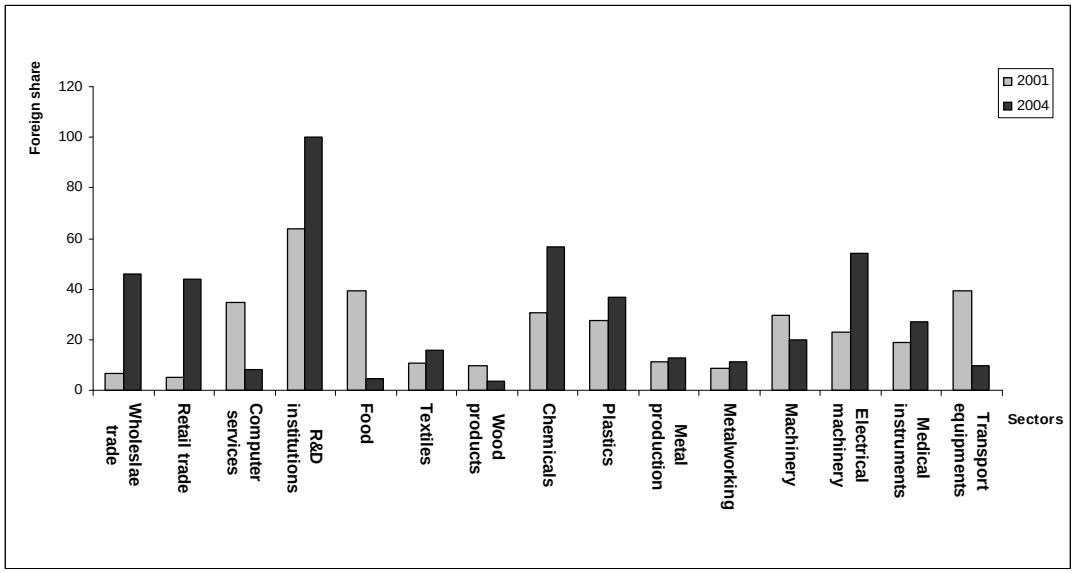

FIGURE 7.9. Percent share of foreign firms in total sales in the same sector and region "Western Switzerland". Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

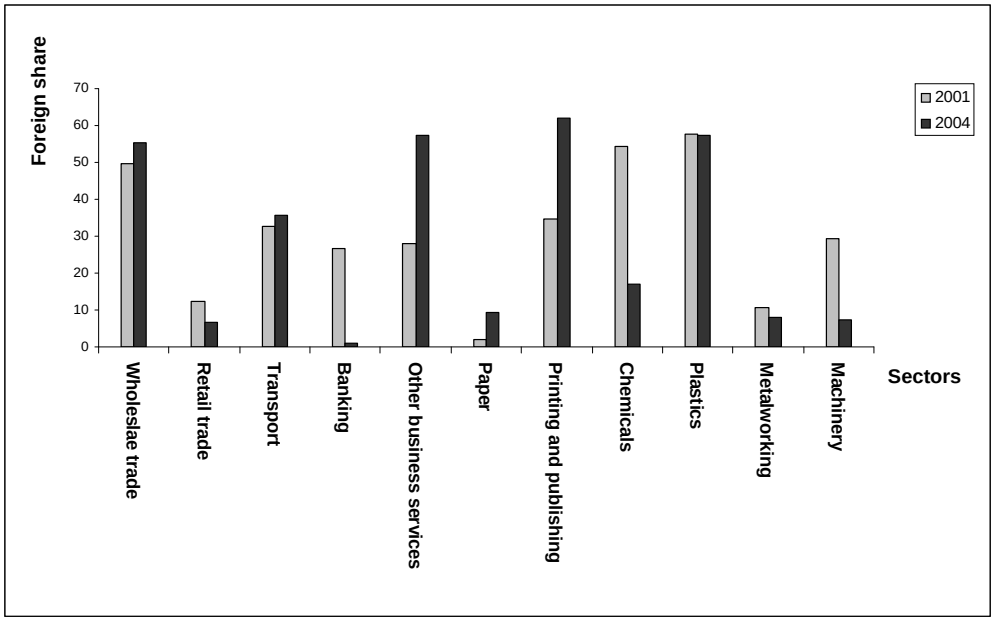

FIGURE 7.10. Percent share of foreign firms in total sales in the same sector and region "Central Switzerland". Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

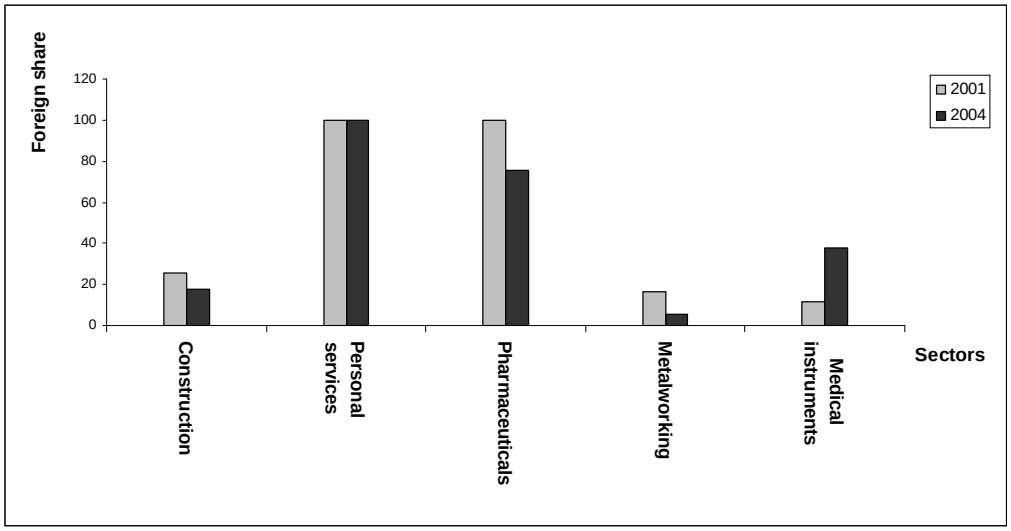

FIGURE 7.11. Percent share of foreign firms in total sales in the same sector and region "Ticino". Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction firms.

2. Affiliates' behavior relative to domestic firms in Swiss industry

Based as above on the author's calculations of individual data of 2306 firms – 314 majority-owned foreign affiliates – in 2001 and 2305 firms – 316 majority-owned foreign affiliates – in 2004 derived from innovation activity surveys (2002 and 2005) of manufacturing and services/construction firms conducted at the KOF institute, this section presents descriptive statistics of the relative position of foreign versus domestic firms in terms of economic performance and human capital development in Swiss industries. Table 7.4 compares the relative performance of foreign and domestic firms across sectors in 2004, measured by total sales, total employment, and exports as a percentage of total sales, using the ratio of foreign to domestic means. In general, the differences in the aggregate indicate that foreign firms in Switzerland are larger in sales and exports (about twice) than domestic firms, but they do not recruit more employees. When disaggregating the sample into manufacturing and other industries, sales and export differences that support foreign firms become quite large and strongly significant in services/construction.[14] This stems from the significant dominance of foreign firms, in terms of sales, mainly in sectors such as beverage, plastics, transport equipment, computer and office equipment, trading and maintenance of motor vehicles, and other business services; and in terms of exports in insurance, construction, transport, banking, R&D institutions, watches, and wood products. Labor difference still favors domestic firms especially in

[14]It is worth noting that sales and export differences also highlight the dominance of foreign firms in manufacturing but they are less important than in services/construction.

TABLE 7.4. The relative position of foreign versus domestic firms: sales, labor, and export (2004)

Ratio of the mean of the foreign variable to the mean of the corresponding domestic variable#			
Sector	sales	labor	exports
All sectors	1.6	0.9	2.2***
Manufacturing	1.5	1.14	1.7***
Food	0.8	0.9	1
Beverage	4**	2	0.3
Textiles	0.8	1	1.6*
Wood products	0.8	0.8	3.8*
Paper	1.8	0.9	1
Printing and publishing	1.2	1.4	1.5
Chemicals	0.5	0.7	1.4*
Pharmaceuticals	0.4	0.4	1.5
Plastics	2.4**	1	1.9*
Non-metal mineral products	1.9	1	2
Metal production	1.1	0.7	1.4
Metalworking	2.5***	1.2	1.5
Machinery	1.1	1.1	1.3**
Electrical machinery	4	2.1	1.1
Computer and office equipment	4.5***	7.7*	0.04
Communication equipment	3.2	1.5**	1.3
Medical instruments	1.2	1.2	1.3
Watches	0.5	0.7	3.3***
Transport equipment	5.5**	2.6*	1.8
Other manufacturing	1.8	0.8	2.3*
Other industries	1.9	0.98	3.7***
Trading and maintenance of motor vehicles	4.2*	1.3	0.1
Wholesale trade	3.7	0.9	1
Retail trade	0.5	0.4	1.6
Tourism	2.7	1	2
Transport	4.7	1	3.9***
Banking	0.4	1	5.3***
Insurance	0.04	0.3	6.3***
Computer services	2.3*	1.4	0.7
R&D institutions	2.1	1.7	5.7***
Other business services	60***	0.7	4.5***
Construction	3.1	1.9*	15.1***

Two-sample t-test for equal means, which for simplicity does not take into account the sample design specificities.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction.

service industries even if it is insignificant – the ratio of foreign to domestic means is mostly less or equal to 1.

Table 7.5 analyzes the relative technological position of foreign versus domestic firms in 2001 and 2004, measured by the share of innovative products in sales,[15] the share of R&D labor, and the labor productivity expressed as value-added per employee. In 2001, the data for the aggregate suggests that on average, foreign firms hire R&D employees and innovate more than domestic firms; their share of R&D labor is one and half more than that of domestic firms, which is significant at the 10% level. In 2004, these differences in favor of foreign firms markedly increase, stemming mainly from services/construction. However, across sectors this result changes considerably; that is, in some sectors the change from 2001 to 2004 remains in favor of foreign firms, particularly in banking and wholesale trade in terms of innovative products and in printing and publishing, machinery, and other business services in terms of R&D labor. While in other sectors such as in banking and in metal production, the change, although insignificant, is in favor of domestic firms in terms of R&D labor and innovative products, respectively.[16]

The difference in terms of productivity denotes the industrial technology gap between domestic and foreign firms, which is significant at the 1% level for both years at the aggregate level (1.6 and 3.6 in 2001 and 2004 respectively) with larger coefficients for services/construction. This shows that on average the gap is relatively high, which marks the relative productivity performance of foreign firms over their domestic counterparts, and appears not be associated with a catching-up process by domestic firms between 2001 and 2004. Nevertheless, when the sectors are considered individually these results change considerably and show that in some sectors the gap is small while in others is tripled. In food, retail trade, and trading and maintenance of motor vehicles, for example, foreign firms perform better than domestic ones, while in chemicals and transport, domestic firms seem to be head and shoulders above the foreign firms. Moreover, sectors like construction and other business services experience a large gap in 2001 associated with a process of falling behind in 2004, whereas food, wood products, watches, and computer services succeed in catching-up with and even in forging ahead of foreign firms. This catching-up process, in our view, may result from the investment effort of domestic firms in learning activity, since, in wood product, machinery, and watches sectors the decrease in the technology gap appear to be jointly related to the increase of the share of innovative products.

Table 7.6 compares the relative technological performance of foreign and domestic firms across regions in 2004, measured by the share of innovative products in sales.[17] At the aggregate level, the difference in favor of domestic firms is in Ticino, mainly in manufacturing (medical instruments). This shows that MNCs attempt to invest in Ticino to be close to domestic knowledge, and this could result, in our view, in spillover benefits for

[15]Innovative products could be goods or services and include new products as well as those that have been consideraly changed. The share of innovative products is measured as a percent of the firm's total sales realized in Switzerland.

[16]Note that there exist sectors in which domestic firms perform better than foreign ones in both periods but these differences are also not significant, except for chemicals.

[17]See definition in footnote 15.

TABLE 7.5. Affiliates' technological behavior relative to domestic firms: labor productivity, R&D labor, and the share of innovative products in sales

Ratio of the mean of the foreign variable to the mean of the corresponding domestic variable#						
	Labor productivity		R&D labor		The share of innovative products	
Sector	2001	2004	2001	2004	2001	2004
All sectors	1.6***	3.6***	1.5*	1.7***	1.1*	1.2*
Manufacturing	1.2***	1.2	1.3*	1.4***	1.1	1.1
Food	1.8***	1.1	1.9	1	0.9	0.7
Beverage	2.2	2	0.2	3.3	0.2	0.1
Wood products	2.5***	0.9	0.6	0.7	0.4	0.05
Paper	1.3	1.2	0.6	0.4	0.6	1.5
Printing and publishing	2.2***	1.2	8***	8***	1.3	1.7
Chemicals	1	2*	0.5**	0.6*	1.1	1.3
Pharmaceuticals	1.3	1.3	0.9	2.3	1.3	1.4
Plastics	1.2	1.2	0.3	0.9	1	1.5
Non-metal mineral products	1.2	1.6	1.1	0	0.6	0.6
Metal production	1.3	1.2	0.2	1	1.5	0.2
Metalworking	1.1	1.3*	0.8	0.3	0.8	0.7
Machinery	1.2***	1.1*	1.3	1.4*	1.1	0.9
Electrical machinery	1.1	1.4***	1	1.6*	0.8	0.9
Computer and office equipment	1.4	1.2	1.4	0.2	1.5	0
Communication equipment	1.1	1.5**	0.6	1.9*	1.1	1.1
Medical instruments	1.1	1.5***	1.2	0.6	1.1	0.9
Watches	1.6**	0.26	1.7	0.5	2.4*	1.5
Other manufacturing	1.3	2.1***	0.2	3.4*	0.7	1.8
Other industries	2.2***	6.6***	1.7	2.5***	1.1	1.4*
Trading and maintenance of motor vehicles	3***	2.5**	0	0	1.9*	2.5
Wholesale trade	1.6***	1.7***	2.2	0.2	1.5*	1.6*
Retail trade	1.7***	1.4*	0	2.4	1	0.7
Tourism	1.1	1.3*	0	0	2.6*	1.4
Transport	0.9	1.5***	0.8	1.9	0.4	1.5
Banking	1.2	0.6	2.9	0.5	1.9*	2.4**
Insurance	1	0.1	0.7	1.2	0.1	1.5
Computer services	1.7*	1.1	0.4	0.04	1	1.4
Other business services	7.6***	70***	3.8**	5.1***	1.4	0.5
Construction	1.6***	2.4***	2.3	1.6	1.4	2.1

Two-sample t-test for equal means, which for simplicity does not take into account the sample design specificities.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction.

TABLE 7.6. Affiliates' technological behavior relative to domestic firms: the share of innovative products in sales within region

Ratio of the mean of the foreign variable to the mean of the corresponding domestic variable#							
	The share of innovative products in sales						
Sector	Reg.1	Reg.2	Reg.3	Reg.4	Reg.5	Reg.6	Reg.7
All sectors	1.1	1.3*	1	1.4**	1.1	1.1	0.6
Manufacturing	0.4**	1.1	0.5*	1.2	1.7	0.7	0.2
Food		0.8			0.4	1.4	
Beverage					0.2		
Textiles		1		1.4	0.6		
Wood products			0.1				
Paper		1.4	3.3				
Printing and publishing		2.5				1.4	
Chemicals	1.2	1	0.9		0.8	3	
Pharmaceuticals			1				
Plastics					1	5.3*	1.1
Non-metal mineral products	1.4			0.4			
Metal production	0.5				0.1*		
Metalworking		0.8	0.9		0.9	0.9	
Machinery	1.1	0.9	0.1*	1.1	0.9	1.9	
Electrical machinery	0.9	0.9	0.6	1.1	1.1	1.6	
Computer and office equipment		0					
Communication equipment		3**		0.7	1.7	0.6	
Medical instruments	1.8	1		1	0.4	1	0.4
Watches		1.2					
Other manufacturing			2.4				
Other industries	1.3	1.2	1	1.2	0.9	1.2	0.7
Trading and maintenance of motor vehicles				1.2			
Wholesale trade	0	1.1	2	1.5	2.5*	1.8	
Retail trade		0	0.6	0.8		1	
Tourism	0.5	1.4		1.7			
Transport			2.5	2.2			
Banking		0	0	2.4	6***	35	
Computer services				1.5			
R&D institutions		2.6					
Other business services	0.7	0.3	0.8	0.2		0.3	
Construction		9.3**		1.1			

Two-sample t-test for equal means, which for simplicity does not take into account the sample design specificities.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Reg.1 refers to Lemanic region, Reg.2 is Mittelland space, Reg.3 is North West Switzerland, Reg.4 is Zurich, Reg. 5 Western Switzerland, Reg.6 Central Switzerland, and Reg.7 Ticino.

Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction.

foreign affiliates. Equal shares are found in North West Switzerland with a strong domestic dominance in manufacturing. This dominance stems, for the most part, from wood products, machinery, and electrical machinery.[18] While in other regions foreign firms predominate, stemming mainly from services/construction, except in Western Switzerland where domestic firms innovate more.[19] Across sectors, in the Lemanic region for example, foreign firms seem to innovate more in sectors like non-metal mineral products, medical instruments, and chemicals, whereas domestic firms perform largely in tourism and metal production. In Mittelland space, foreign firms predominate in paper, printing and publishing, communication equipment, and construction; while sectors like food, metalworking, and other business services are rather dominated by domestic innovations. These results clearly demonstrate that within the same region, possible signs of spillovers from and to the MNCs' affiliates may take place – this provides evidence confirming our hypothesis that spillovers are highly likely to be localized. Moreover, the table shows that for some sectors foreign firms dominate in a region while their domestic counterparts dominate in another; this shows that for the same sector both may occur spillovers and reverse spillovers depending on the region.[20]

Finally, table 7.7 analyzes the relative contribution of foreign firms to domestic human capital development versus their domestic counterparts, in 2004. The variables used are the share of professionals – engineers, managers, and all other professionals in production and R&D activities – in total employees, the labor quality index expressed in terms of the ratio of professional to non professionals, the share of R&D employees, and the share of labor cost in sales (including salary, training expenditures, etc.). The data for the aggregate suggests that, although foreign firms are not larger than domestic ones in terms of employment, they hire more professionals which for the most part consist of R&D employees, the quality of their labor force is significantly higher, and they invest more in labor cost. The high level of labor costs observed in foreign affiliates relative to similar domestic firms may result from the large amount they spend on training.[21] In this way, MNC's affiliates may be particularly valuable sources of new technology and hence we believe that more opportunities for spillover benefits are expected. As suggested by Blomström and Kokko (2002), the labor market is one of the main ways in which new technological knowledge is expected to disseminate to the domestic economy, workers already trained by or having worked in foreign affiliates may be potentially available to work in domestic firms or start their own firms in the same industry. These differences in favor of foreign firms are significantly larger in services/construction than

[18]Note that in sectors like paper, wholesale trade, and transport, foreign firms dominate.

[19]Although across sectors, this region shows a large share of innovative products in favor of foreign firms in for example banking and wholesale trade -foreign firms also predominate in those sectors in Zurich and Central Switzerland.

[20]For example, the machinery and chemicals sectors are dominated by foreign firms in Western Switzerland and by domestic firms in Central Switzerland.

[21]Chen (1983) and Gershenberg (1987) found evidence that foreign firms spend more on training than domestic firms in Kenya and Hong Kong, respectively.

in manufacturing, and show that human capital is most important in services. Across sectors, the results in table 7.7 show that foreign firms hire more professionals and possess a more skilled labour force in sectors such as chemicals, trading and maintenance of motor vehicles, and wholesale trade; and invest more in labor costs in banking, retail trade, plastics, transport equipment, electrical machinery, and also trading and maintenance of motor vehicles and wholesale trade.

3. Conclusions

This chapter has examined the FDI distribution in the global economy and in Switzerland, and studied the relative position of foreign versus domestic firms in terms of technological behavior, productivity performance, and human capital development. We find that Switzerland experiences increasing flows of inward FDI over time; it is is one of the small European countries which, like Austria and Norway, recorded sharp increases in inward FDI over the last few years, mainly in 2003, which even surpassed those of outward investment. In general, foreign affiliates are well involved in Swiss economic activity, in that, firstly, the share of foreign presence is quite large: in total sales it is as high as 21% in 2001. And secondly, foreign firms perform better than domestic ones, innovate more, and hire more professionals which mostly consist of R&D employees.

The degree of foreign presence in Switzerland as well as the relative performance of foreign firms compared to their domestic counterparts are neither evenly distributed across sectors and regions, nor just the same maintained over time. Some sectors and regions have experienced a large presence with a significant dominance of foreign firms while others have not. Also, some of the domestic firms seem to have succeeded in catching up with foreign affiliates between 2001 and 2004 during which time their productivity increased and their technology gap narrowed.

Whether at least some of the increases in domestic productivity are due to spillover benefits arising from the learning process of foreign technologies is the focus of our empirical analysis discussed in the following chapters. This issue is first addressed in chapter 8 on the basis of a qualitative analysis from interviews with both foreign and domestic firms.

TABLE 7.7. Human capital development: difference between foreign and domestic firms (2004)

Ratio of the mean of the foreign variable to the mean of the corresponding domestic variable#				
Sector	Professional employees	Labor quality	R&D employees	Labor cost
All sectors	1.1***	1.7***	1.7***	1.2***
Manufacturing	1.1***	1.7***	1.4***	1.2**
Food	1.2	3***	1	1.1
Beverage	1.3	2.1	3.3	1.1
Textiles	0.9	0.7	0.7	1.1
Wood products	1.1	0.8	0.7	1.2
Paper	1	1	0.4	1
Printing and publishing	1.1	2.6***	8***	1.1
Chemicals	1.1*	3.2***	0.6*	1.1
Pharmaceuticals	1.1	2.2	2.3	1.1
Plastics	1	0.9	0.9	1.2**
Non-metal mineral products	1	0.7	0	1.1
Metal production	1.1	0.9	1	1.1
Metalworking	1	0.9	0.3	1.1
Machinery	1	1.4	1.4*	1.2***
Electrical machinery	1.1	1.2	1.6*	1.3***
Computer and office equipment	1.4	7.5***	0.2	1.3*
Communication equipment	1	0.7	1.9*	1.3*
Medical instruments	1	1.2	0.6	1.1
Watches	1.4	1.1	0.5	0.4
Transport equipment	1	1	0	1.5**
Other manufacturing	1	0.7	3.4*	1.3
Other industries	1.2***	1.9***	2.5***	1.4**
Trading and maintenance of motor vehicles	1.3***	1.7*	0	1.8***
Wholesale trade	1.3***	2.9***	0.2	1.4***
Retail trade	1	2.2***	2.4	1.3*
Tourism	0.9	0.7	0	1.2
Transport	1	0.5	1.9	0.9
Banking	1*	2.2***	0.5	1.5***
Insurance	1	0.4	1.2	1.1
Real estate and leasing	1.2	1	0	1.1
Computer services	1	1.4	0.04	1
R&D institutions	1	0.3	1.7	0.7
Other business services	1	0.7	5.1***	1.1
Construction	1	0.8	1.6	1.3**

Two-sample t-test for equal means, which for simplicity does not take into account the sample design specificities.

*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Source: Author's calculations of data derived from KOF innovation surveys (2002 and 2005) of manufacturing and services/construction.

CHAPTER 8

Empirical evidence: interview analysis

This chapter focuses on analyzing a number of interviews with managers of domestic and foreign firms in Switzerland. The objective of this analysis is to examine qualitatively the pertinence of our hypotheses discussed in previous chapters as applied to Swiss industry. Our hypotheses suggest that the size and the extent of spillover effects depend largely upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. And spillovers are more pronounced in locations where domestic firms are close to their foreign counterparts. The interview results seem to support the hypotheses.

In the next section we present the methodology adopted for our interviews. Then we discuss in section 2 the interview results with Swiss and foreign firms.

1. Setup and methodology

83 foreign and domestic firms operating in Switzerland were contacted for interviews,[1] but, as we note in the next section only 43 firms were effectively interviewed. The firms and industries have been selected according to the industry's and the firm's technological capacities, so as to have a heterogeneous firm sample with diverse technological levels. The industry's and firm's technology gaps are used to measure the industry's and firm's technological capacities, derived from innovation activity surveys (2002) of manufacturing and services/construction firms, conducted at the Swiss institute for business cycle research "KOF". The firm's technology gap is defined as the ratio of the average labour productivity of foreign-owned firms in the relevant industry to the domestic firm's own labor productivity.[2]

In the case of domestic firms, we are first interested in the principal activities of the firm; then, whether it benefits from the foreign presence in its industry and specifically if this benefit occurs through the increase of competition or the acquisition of foreign technology. Third, we are looking at how foreign technology is transferred to the domestic firm, especially whether it is through discovering foreign comparative advantage and/or recruiting domestic employees previously trained by or having worked in foreign firms

[1] It is worth noting that a larger number of firms could be more relevant to interview to test our hypotheses. Unfortunately, this is not possible due to the constraint of names confidentiality set by the KOF institute.

[2] For industrial technology gap, we apply the ratio of the average labour productivity of foreign-owned firms in the relevant industry to the average domestic firms own labor productivity.

("MNCs' labor"). Fourth, we seek to understand through which channel such benefit is maximized. And finally we are interested in the existence of nearby foreign affiliates and their importance in increasing the benefit of domestic firms. A detailed list of the questions addressed to domestic firms is given in box 1.

Box 1. *Questionnaire for Swiss firms*

- Could you describe the principal activities of your firm?
- What are your responsibilities within the firm?
- Could you explain how your firm maintains its market share and survives with the foreign competition? Is it an easy task?
- Does your firm benefit from the foreign presence in the industry? How? And at kind of benefit is it?
- Does your firm benefit from the increased competition that occurs as a result of foreign entry? Could you describe how? Does this kind of competition force your firm to introduce new technology and/or work harder so as to increase its productivity?
- Does your firm benefit from foreign presence in the industry in terms of technology transfer when foreign firms demonstrate their products to clients and also in firms' meetings? Could you describe how?
- Does your firm recruit domestic employees trained by or have worked at foreign rivals? "If yes", which kind of employees and how many? Does your firm benefit from the know-how these employees took with them after leaving the foreign firms? Could you describe how?
- Through which channel (demonstrations, the increase of competition, and/or the recruitment of domestic employees previously trained by or having worked at foreign rivals), is the benefit from foreign rivals maximized?
- Are there any foreign rivals in your region? "If yes", is your presence near these foreign firms beneficial, in terms of the benefit discussed previously?
- Has the boss of your firm gained experience or been trained by foreign multinationals and/or their affiliates in the same industry?

Definition of technology: Intangible assets such as methods, techniques, technological know-how, marketing and managerial skills, and international experience.

In the case of foreign firms, we are also looking at the principal activities of the firm, but especially its reasons for choosing to be present in Swiss territory. Second, we want to know whether it gains the estimated benefits from its presence in Switzerland, close to its domestic counterparts. And finally, we are interested in the domestic employees it recruits, whether they need some training courses, and whether they leave the firm after having

been trained or worked in it. A detailed list of the questions addressed to foreign firms are given in the box 2.

BOX 2. *Questionnaire for foreign affiliates established in Switzerland*

- Could you describe the principal activities of your firm?
- What are your responsibilities within the firm?
- Why did your firm choose Switzerland and this particular region to set up an affiliate? Does your firm benefit from its presence in Switzerland? How? (Is it from high quality infrastructure, attractive tax system, and/or Competitive environment, etc)?
- Does your firm benefit from the competition with domestic rivals? How does this benefit materialize?
- Does your firm benefit from its presence in Swiss industry in terms of technology transfer when domestic firms demonstrate their products to clients and also in firms' meetings? Could you describe how?
- Are there any Swiss rivals in your region? "If yes", is your presence near those domestic firms beneficial, in terms of the benefit discussed previously?
- Does your firm recruit domestic employees? Are they qualified? Do they need some training courses? What kind of employees do you recruit (i.e. simple manufacturing operative, supervisor, technically advanced professional, and/or top-level managers), and how many per year (approximately)?
- Do domestic employees you have recruited leave the firm after working or training within your firm? If yes, why? How many (approximately), and does this affect your performance?

Definition of technology: Intangible assets such as methods, techniques, technological know-how, marketing and managerial skills.

After the selection of the firms to interview, a phone call was made with each of them so as to collect the individual information on "top and middle level managers" whom we want to interview. Then, a letter describing the aim of our project with an overview of the questionnaire was sent to each person. Boxes 3 and 4 in appendix 6 summarize the letters sent to managers of domestic and foreign firms, respectively. And after a while phone calls were made with those managers asking them for interviews. We offered two types of interviews: personal and by phone, since some key actors were not able to take the time to give personal interviews.

2. Interview results with Swiss and foreign firms

This section makes use of a sample of 43 firms operating in Switzerland, divided into 30 domestic firms and 13 majority-owned foreign affiliates of diverse industries from manufacturing and services/construction.[3] Individual firm information is derived from interviews we made with managers of such firms. The response rates were 50% for domestic firms and 57% for foreign firms, which is quite satisfactory in view of the reluctance of firms to reveal data considered as confidential and also the irrelevance of the topic for some of them. Our interviews with managers of enterprises suggest that all of our hypotheses are prevalent to Switzerland. Results from these interviews are grouped into the following points. The first four points are drawn from interviews with managers of foreign firms and the rest analyzes those held with domestic firms:

(i) The main motives of foreign MNCs for setting up affiliates or acquiring existing domestic firms in Switzerland are: 1) to seek new competitive markets since the Swiss environment is characterized as competitive in many industries; 2) Switzerland is in the center of Europe and it is easy to use its high quality infrastructure to quickly reach any other European country; and 3) to acquire additional assets which protect or augment their existing created assets in some way; this attitude is markedly observed in sectors such as banking, chemicals, and pharmaceuticals where Swiss firms are highly competitive using state-of-the-art technologies.

(ii) Foreign firms are active in training domestic employees; they provide different kinds of training which can be on-the-job training or training courses in Switzerland or abroad. Those courses could be summarized as follows: 1) the basic course for any new domestic employees makes them familiar with the firm's policies, its structure and the work environment; 2) technical training directed towards enhancing the technical expertise of the employees in some specific firm's technology; and 3) management training, noting that managers are in some cases expatriated from parent companies. Dr. Ravi Yellepeddi, Technical Director, XRF & XRD, of the scientific instruments division for Thermo Electron SA states that "*95% of the employees are domestic, the firm expatriates only a few employees, namely in the field of accounting and controlling, in order to bring the MNCs' activities under common control. Thermo Electron spends a large amount on different forms of training, first courses for every new employee, general (such as organizational, managerial or marketing skills) and firm-specific technology-courses per responsibility, in the affiliate and abroad*".

In addition, according to the data, foreign firms give high salaries for domestic employees even for unskilled ones.

[3]Those industries consist on pharmaceuticals, chemicals, medical instruments, machinery, tobacco, printing and publishing, wood products, beverage, electrical machinery, computer and office equipments, trading and maintenance of motor vehicles, transport, construction, computer services, insurance, banking, R&D institutions, wholesale trade, and other business services.

(iii) For Swiss' employees, we recognize that the social dimension is of great importance in order to preserve their position in the firm, in the sense that they may leave the foreign affiliate to join an existing domestic firm so as to get better work conditions for the same salary or even for a slightly less.

(iv) Most foreign firms in Switzerland are engaged in R&D and have their own laboratories, but also in some cases they do import technologies consisting mostly of complementary technologies from mother companies to improve their technological development.

(v) In terms of domestic firms, most of them argue that the entry and the presence of foreign counterparts are beneficial in the sense that they stimulate their productivity development in many ways. For industries such as insurance, chemicals, medical instruments, and electrical machinery, productivity enhancement of domestic firms mainly results from their interaction with foreign counterparts, inducing them to use their existing technology more efficiently by learning within its existing line of technological development. Domestic firms in such industries do not need to learn from foreign technologies to increase their productivity since, as shown in the previous chapter, they perform as much as foreign counterparts. Moreover, such firms are generally on the alert, trying to constantly observe what foreign firms do. Mr. Michel Segesser, Vice President and Head HR Business Support of Winterthur insurance claims that "*foreign presence is important to keep efficiency, in that the market becomes more dynamic and then each actor (domestic and foreign firms) has to improve its position by upgrading its technological and market capacities. Particularly for Winterthur insurance, competition with foreign firms motivates the technological upgrading of the firm and offers the opportunity to evaluate its capacities*".

(vi) However, to face foreign competition and maintain their position in the market, domestic firms from industries such as machinery and computer and office equipment, qualified as a mid-technological level group, attempt to improve their technological competence by learning the best foreign knowledge. They attend lunches with foreign and other domestic firms operating at different levels of technology to exchange information. They try to recognize valuable new knowledge and integrate it into their technological process in order to reduce inefficiency by observing product innovation, new management techniques, etc. when foreign firms demonstrate their advanced technologies.

Obviously, sine local businesses come into contact with existing users, information about the best technology is diffused and imitation levels increase. However, the results show that domestic firms do not just imitate foreign knowledge, they also invest in their own R&D to make their private adjustments and so progress and not by simply following.

(vii) Besides, there exist domestic firms prefer to get hold of information about new techniques and methods not only through observing what others do, but also by trying to acquire technological know-how via the acquisition of human capital. For example, domestic firms that are far behind the technological frontier in industries such as trading and maintenance of motor

vehicles, beverage, computer services, and other business services provide some evidence for productivity development by the use of foreign knowledge embedded in "MNCs' labor". They gain a lot from the international experience of these employees. This is not surprising in a way, given the finding in the previous section that foreign firms in, for example, computer services and other business services seem to spend a large amount on training with a relatively high quality of labor.

Moreover, some domestic firms claim that recruiting "MNCs' labor" is too difficult regarding the cost and the availability of the valuable employees. In wine industry for example such labor is not available on the Swiss market since foreign MNCs in this industry keep both innovative and productive activities in the origin country while their affiliates in Switzerland are only responsible for selling the product. So, to get in touch with foreign knowledge some domestic firms invest in training their employees within foreign firms abroad.

It is worthy to note in addition that the technique of recruiting "MNCs' labor" seems to have not been used by domestic firms in industries using traditional technologies such as construction; these are instead satisfied by simply observing what foreign firms do.

(viii) A great number of the head managers of domestic firms have gained experience in the foreign counterparts within either the affiliates or the mother companies.

(ix) Finally, it seems that the geographical dimension plays an important role in the productivity enhancement of domestic firms, especially for mid and low technology firms, in that the proximity of foreign firms to domestic counterparts allows for a better transfer of foreign technologies with less cost; for example, it becomes easier to go to meetings and lunches. Nonetheless, as asserted by key actors of firms from machinery and computer services, if domestic firms are still not able to get access to the best foreign technology, the pressure of the foreign competition together with geographical proximity hinder their development process since those firms are not in a position to compete fiercely with foreign counterparts.

3. Conclusions

In this thesis we attempt to offer a more comprehensive picture of FDI intra-industry spillovers by distinguishing these effects according to their diverse channels. We assume that the size and the extent of such spillovers depend largely upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. And regional proximity is an important element in determining the size and the extent of spillovers. Our hypotheses are tested against the empirical evidence for the Swiss economy using qualitative and quantitative data analyses .

Chapter 8 has discussed a number of interviews made with managers of domestic and foreign firms established in Switzerland and characterized by various technological capabilities. We find that all of our hypotheses are

prevalent in Switzerland, a country in which high and mid technology firms tend to benefit a lot from, respectively, competition and demonstration effects; while low technology firms which are not able to benefit from foreign affiliates via demonstration effects alone manage to reap benefits via the recruitment of the MNCs' human capital since this channel provides some assistance which can help them to successfully imitate the best foreign technology. Interview results also show that geographical proximity is of great importance for spillovers, especially for mid and low technology domestic firms.

However, the scant empirical evidence available in this chapter does not allow for the measurement of the size and the extent of spillovers; so additional quantitative analyses would help to make this kind of measurement (chapter 9).

CHAPTER 9

Empirical evidence: regression analysis

In the previous chapter we empirically analyzed the spillover effects of FDI based on a number of interviews made with managers of domestic and foreign firms in Switzerland. We found that the interview results seem to support the hypotheses of the thesis in which high and mid technology firms tend to benefit a lot from competition and/or demonstration effects; while low technology firms which are not able to benefit from foreign affiliates via demonstration effects alone, manage to reap the benefits via the recruitment of the MNCs' human capital. The results also demonstrate that geographical dimension matters for spillovers in Switzerland.

However, as mentioned before, interview analysis does not allow for the measurement of the size and the extent of spillovers. Obviously, further quantitative analysis would help to make this kind of measurement. This chapter attempts to test for spillovers from FDI using firm-level data from both manufacturing and services/construction[1] industries in Switzerland.[2] Particularly, our attention is focused on testing the size and the extent of intra-industry spillovers according to the mechanisms by which they occur, the levels of technological capacity of domestic firms – expressed in terms of technology gaps, and the levels of their learning and investment efforts undertaken to absorb foreign knowledge.[3] We also test whether spillovers in Switzerland are regional.

The data for econometric analysis is derived from innovation activity surveys (2002 and 2005) of manufacturing and services/construction firms, with at least 5 employees, conducted at the KOF institute. The regression analyses make use of a sample of only 657 firms, 370 in manufacturing and 287 in services/construction, because of missing data for some variables when matching the two data sets from the 2002 and 2005 surveys.

Our regression findings seem to confirm to a large extent the interview results, in which we find that domestic firms with a high technological capacity appear to benefit from spillovers which are basically from the FDI heightening competition. Mid technology firms benefit a lot from demonstration effects, while low technology firms which are not able to benefit from foreign

[1]This study tries to bridge the gap by testing the presence and the extent of spillovers for service/construction industry since there is hardly any of this aspect.

[2]We have to note that future work aiming at testing for reverse spillovers could also be interesting since in some industries MNCs set up affiliates in Switzerland to be able to learn from the best Swiss technologies.

[3]Doing so, we make use of a thorough measure of domestic absorptive capacity in which the learning and investment efforts of domestic firms come with their existing technological capacities.

affiliates via demonstration effects alone manage to reap spillover benefits via the recruitment of the MNCs' labor which can help them to successfully imitate foreign knowledge. Regression results also demonstrate that only the firms that largely invest in the absorptive capacity benefit from spillovers which mainly result from the technology transfer. In addition our findings confirm that regional dimension matters for spillovers in Switzerland. Our empirical results are found to be more consistent in manufacturing than services/construction.

The structure of the chapter is as follows. Following this introduction, section 1 presents the econometric model, section 2 presents the estimation results, and section 3 concludes the empirical findings and offers some policy prescriptions.

1. Econometric model

We model the effects of FDI intra-industry spillovers within the context of a production function,[4] in which the change in the natural log value-added of the i-th domestic firm is determined as follows:

$$\begin{aligned}\Delta LnY_{i,j} &= \alpha_0 + \alpha_1 \Delta LnK_{i,j} + \alpha_2 \Delta LnL_{i,j} + \alpha_3 FP_j + \alpha_4 HC_{i,j} \\ &\quad + \alpha_5 FP_j * HC_{i,j} + \alpha_6 \Delta Comp_{i,j} + \alpha_7 \mathrm{Si}\,ze_{i,j} \\ &\quad + \alpha_9 Industry_j + \varepsilon_{i,j}, \quad (1.1)\end{aligned}$$

where the subscripts i and j denote firm and industry, Δ represents changes in the variables between 2001 and 2004, and α_0, α_1, α_2, α_3, α_4, α_5, α_7, α_8 and α_9 the parameters to be estimated. Table 9.1 describes the variables and their measurements.

Y denotes value-added at firm level, K its physical capital, L its employment, and HC the level of its human capital. The coefficients of those variables are expected to be positive and significant. $\mathrm{Si}\,ze$, defined by the sales of firm i, is expected to increase productivity since larger sized firms may be more efficient (Dimelis and Louri, 2002). The inclusion of industry dummies,[5] $Industry$, in equation (1.1) and the use of changes over time control for industry-specific productivity differences; they correct for the omission of unobservable variables that might undermine the relationship between spillover variables and the productivity growth of domestic firms (Aitken and Harrison, 1999 and Narula and Marin, 2003).

To assess the overall spillover effects of foreign firms on domestic competitors, we employ three different control variables with respect to three possible intra-industry spillover mechanisms: first, the main effect[6] of the

[4] The derivation of this model is explained in appendix 7.

[5] There are 32 industry dummies accounted for manufacturing and 19 dummies for services/construction.

[6] It is also called the average effect (Aiken and West, 1991) since it denotes the effects of the FP on domestic productivity at the mean of HC as those variables used for interaction are centered (more details are given in the table footnotes of appendix 8)

1. Econometric model

TABLE 9.1. Variable definitions

Variables	Definitions
$\Delta LnY_{i,j}$	The log change in value-added at the firm level.
$\Delta LnK_{i,j}$	The log change in physical capital, measured by gross capital income – firm level.
$\Delta LnL_{i,j}$	The log change in total number of employees in a firm.
FP_j	The share of total sales in an industry j accounted for by foreign firms.
$FP_{j,r}$	The share of total sales in an industry j within the region r accounted for by foreign firms, $r = 1...R$, with $R = 7$.
$FP_{j,R-r}$	The share of total sales in an industry j outside the region r accounted for by foreign firms.
$HC_{i,j}$	The average labor cost of the firm (in 100'000 CHF) constructed as the ratio of the firm's labor costs to the number of employees.
$\Delta Comp_{i,j}$	The change in price markup at firm level measured by the difference between firm's total sales and costs over total sales.
Si ze_{ij}	The log total sales of the firm.
$GAP_{i,j}$	The ratio of the average labour productivity of foreign-owned firms to domestic firm's own labor productivity, calculated for 2001.
$INVEST_{i,j}$	The level of investment expenditures in new equipment and training activities for product/process innovation, within the period 2002-2004.

share of foreign presence at the four-digit industry level,[7] FP,[8] reflects spillovers from demonstration effects, resulting from the technology transfer that occurs from the direct contact between local agents and foreign affiliates operating at different levels of technology (Ben Hamida and Gugler, 2006).

Second, the interaction term $FP * HC$ between foreign presence and human capital is assumed to determine the effect of worker mobility related to the presence of foreign firms in the domestic market. In fact, this interaction assesses the combined effect of those variables on the productivity of domestic firms; that is the influence of foreign firms would be co-determined by the level of human capital of the domestic firms. It is argued that human capital increases the ability of domestic firms to benefit from positive spillovers (Borensztein et al., 1998 and Meyer and sinani, 2001) – the sign of the interaction effect is then expected to be positive. Moreover, the technique of upgrading the level of the firm's human capital depends on its existing

[7] We make use of the maximum available disaggregation industry level to be able to effectively assess the intra-industry spillover benefits.

[8] Note that at this stage we do not take ino consideration the effect of the regional dimension on spillovers and instead assume that spillover effects dissipate through the whole industry, regardless of location.

technological level. On the one hand, relatively high technology firms attempt to benefit from spillovers through demonstration and/or competition effects (Mody, 1989). Thus, the ability of such firms to either absorb foreign technology or pursue independent lines of technological development, associated with the quality level of human capital, would be largely determined by the amount these firms spend on training their existing employees and/or the new ones so as to acquire the specific techniques required either for the implementation of foreign knowledge or for the development of the existing one. On the other hand, small technology firms are not able to benefit from foreign affiliates via demonstration effects alone as they do not possess a sufficient level of human capital to allow them to efficiently exploit the foreign technological opportunities, rather they gain a lot from worker mobility, since this channel provides a (technical, managerial, etc.) assistance which can help them to better understand and implement foreign technology (Ben Hamida, 2006a). For that, to upgrade their level of human capital and then be able to properly use the best foreign technology, these firms tend to invest in recruiting domestic employees already trained by or having worked in foreign firms by giving them higher salaries than foreign firms do[9] – it is assumed that when leaving the MNCs these employees will take with them some or all of the firm's specific knowledge (Blomström and Kokko, 2002). Note that tables 7.5 and 7.7 in chapter 7 describe the relative technological position of foreign versus domestic firms in 2001 and 2004 and their relative contribution to the development of human capital in 2004, respectively. We find that many relatively small technology firms in 2001, which spend as much as or even more than foreign firms on labor costs, experience in 2004 an increasing level of their technological development.[10] This could be explained by the fact that these firms have succeeded in attracting skilled domestic employees working in foreign firms, qualified as appropriate to their productivity enhancement.

Third, regarding competition-related spillovers, we use price markup or the so-called Lerner index as a measure of competition – the difference between the firm's price (p) and its marginal cost (mc) over its total price. Lerner Index measures the degree to which firms can markup prices above marginal cost; the larger the Lerner index, the greater the power of the monopolist. The Lerner index is also known as the Market Power index (Baye, 2006) as it describes the power a firm has within a market; e.g. a monopoly has the power to set high differences (p - mc) and so will have a high Lerner Index, while, in a highly competitive market, each firm will have a tight value of (p - mc) and low Lerner index.

Unfortunately the data sets available do not allow for the firm's price and marginal cost information. So, following Narula and Marin (2003) and Chung (2001) we use the difference between the firm's sales and its costs over its total sales as a measure of the firm's price markup. When markup is high, a value near 1, competition is low. While, when markup is low, a

[9] As noted in part 2 of the thesis, foreign affiliates are unlikely to be mute spectators since their employees move to domestic competitors taking with them their secrets.

[10] Domestic firms of industries such as computer services and watches succeeded in catching-up with foreign rivals.

value near 0, competition is high.[11] since competition-related spillovers are associated with the increase in the level of competition that occurs as a result of foreign entry and presence, it seems more appropriate to use the change in markup to measure the change in the level of competition. A negative coefficient estimate attracted by the change in markup is consistent with the expectation that decreased markup (increased competition) is followed by a productivity increase.

To test our hypotheses, in which the size and the extent of spillover effects may vary according to the diverse levels of technology capacity of domestic firms and their absorptive capacity with respect to learning and investment efforts, we proceed to make various tests using equation (1.1). As a first step, we divide our full sample of domestic firms into three sub-samples characterized by the size of their existing technological capacities and estimate equation (1.1) separately for domestic firms with high, mid, and small technological capabilities. The existing technological capacities of domestic firms are measured by their technology gaps, GAP, compared to their foreign counterparts. GAP is defined as the ratio of the average labour productivity of foreign-owned firms in the relevant four-digit industry to a domestic firm's own labor productivity, calculated for 2001. Hence, GAP is equal to one if domestic firms operating at the same labour productivity as the average of their foreign counterparts. Values that are smaller than or equal to one – the technological frontier of the industry – are interpreted as signs of small productivity gaps. Values which are higher than one but not far behind the technological frontier of the industry are interpreted as signs of mid productivity gaps, and those which are far behind the technological frontier characterize high productivity gaps. We expect to find stronger signs of competition-related spillovers in the sub-sample with small technology gaps, whereas demonstration- and worker mobility-related benefits tend to take place in sub-samples with mid and high technology gaps, respectively.

As a second step, we divide the full sample into two sub-samples according to the investment level of domestic firms, $INVEST$, in the absorptive capacity. $INVEST$ is measured by the level of investment expenditures in new equipment and training activities for product/process innovation, within the period 2002-2004. We expect that only domestic firms which largely invest in absorptive capacities benefit from FDI spillovers.

It is argued in previous chapters that geographic proximity is an important element in determining the size and the extent of spillovers. In fact, given that labor turnover and imitation are among the more important channels for spillovers, domestic firms that are located near foreign firms may be more likely to benefit than other more distant firms since knowledge is generated and transmitted more efficiently via local proximity and its transmission costs are assumed to increase with distance (Audretsch 1998). Then spillover benefits are highly likely to materialize in locations where domestic firms are close to their foreign counterparts (argument advanced by Aitken and Harrison in 1999) – in this case, spillovers are called "regional"

[11] Note that in some cases a higher markup may be due to industry specificities such as, for example, in the luxury industry (Narula and Marin, 2003).

in scale.[12] Following Aitken and Harrison, in order to test for the regional dimension, we include in the specification above (equation (1.1)) both the regional foreign share and that from outside the region rather than sectorial foreign share. Regional foreign share is measured by the share of sales in an industry within a region employed by foreign firms. The regions considered here are the same as in chapter 7: the Lemanic region, Mittelland space, North West Switzerland, Zurich, Western Switzerland, Central Switzerland, and Ticino.

As some foreign firms could be attracted to regions which benefit from agglomeration economies (Aitken and Harrison, 1999), we include in equation (1.1) seven regional dummies to account for agglomeration effects that may result in an upward bias of a region-specific spillover coefficient.[13]

We test for the equality of coefficients across sub-samples using Chow-tests. All results are robust and refer to OLS estimations of equation (1.1).

2. Regression results

Regression estimates, tables 9.2, 9.3, 9.4, and 9.5 in appendix 8 show the results of the spillover tests, at both the sectorial and the regional levels, for Swiss manufacturing and services/construction firms regarding GAP and $INVEST$, respectively.

2.1. Spillovers at sectorial level. Columns 1, 3, 4, and 5 in tables 9.2 and 9.4 and columns 1, 3, and 4 in tables 9.3 and 9.5 are confined to spillover tests at the sectorial level. The value-added of the firms in Switzerland for the full samples increases with changes in the employment and the human capital of domestic firms, in which manufacturing firms appear more sensitive than services/construction ones. However, as expected, the estimated coefficient of the variable FP is positive but insignificant – significantly negative in column 1 of table 9.4, showing that foreign presence does not have any effect on the productivity growth of domestic firms; so on average there is no evidence of technological spillovers from demonstration effects. The interaction term between FP and HC is also insignificant for both manufacturing and services/construction, indicating that the full sample data has not demonstrated that the change in response with FP depends on the level of human capital. Similarly, the increase in Competition seems to impede the productivity growth of domestic firms since the $\Delta Comp$ estimate is persistently positive and highly significant – only in column 1 of table 9.5 is the $\Delta Comp$ coefficient negative but not significantly so. And the physical capital and Si ze do not significantly affect the productivity change of domestic firms except in services/construction where the ΔLnK estimate appears to

[12] The data available allows only for testing the role of the regional dimension in determining the size of spillovers arising from the technology transfer process. To make such test for the competition-related spillovers, we would need additional information, particularly those related to the type of the firm's product.

[13] The industry dummies are also taken into account when testing for regional spillover effects. Due to missing data, the number is reduced to 23 dummies for manufacturing and 13 for services/construction.

be positive and highly significant (see column 1 of tables 9.4 and 9.5), and the Si ze coefficient is positive and significant only in column 1 of table 9.4.

In column 3, 4, and 5 of tables 9.2 and 9.3, we have proceeded to divide the samples of manufacturing and services/construction, respectively, into three sub-samples characterized by the values for the variable GAP. The results for manufacturing firms suggest that the estimated coefficients of FP and $FP * HC$ are only positive and significant in the sub-samples of firms with mid and large technology gaps – when GAP is greater than one. Both kinds of firms manage to fully exploit the technological opportunities arising from their direct contact with foreign firms – demonstration-related spillovers. The size of such benefits is 0.009 for mid technology firms while 0.005 for low technology ones, implying that an increase in the share of foreign investment from 0 to 10 percent leads to as much as 0.05 percent-point increase in domestic productivity of the low-level group and about twice that for the mid-level group.[14] Mid and low technology firms also gain benefits from FDI by investing in human capital; the amount these firms spend on training their existing employees and/or the new ones appears to be of great importance for the successful implementation of foreign knowledge. The positive and significant interaction the effects of FP with HC indicate that the effect of foreign firms is broadly co-determined by the level of human capital of the domestic firms – this finding confirms the strong association between FDI effects and the level of domestic human capital. Moreover, as we have mentioned in the previous section, domestic firms and especially low technology ones tend to upgrade their level of human capital by recruiting domestic employees already trained by or having worked in foreign firms. By doing so, low technology firms may get hold of some personnel assistance, essential to be able to decode and effectively use the best foreign technology. In this respect, the positive and highly significant interaction effect of FP with HC – column 5 of table 9.2 – could be a sign of worker mobility-related spillovers. This result seems consistent with Ben Hamida's (2006a) theoretical analysis.

The estimated coefficient of $\Delta Comp$ is negative and significant only for the sub-sample of domestic firms with small technology gaps, suggesting that heightened competition (decreased markup) is followed by a productivity increase – the sub-samples of mid and low technology firms do not benefit from the competition-related spillovers since $\Delta Comp$ is significantly positive there. The estimated coefficients of FP and $FP * HC$ are insignificant for the high technology manufacturing firms. This is not surprising given that the high technology firms do not need to learn from foreign technologies to increase their productivity since they perform as much as or even better than their foreign counterparts in the industry. Instead, we find that these firms gain benefit from FDI via competition effects; the competitive pressure generated by the presence of foreign firms induces them to more

[14]Compared to Ben Hamida and Gugler's (2006) regression results of demonstration-related spillovers for manufacturing, the effect of FP in 2001 on the productivity change of mid technological firms between 2001 and 2004 is smaller than that of 1998 on the change between 1998 and 2001.

efficiently use their existing technology by learning within their existing line of technological development.

The estimated coefficients of HC are positive and significant for all sub-samples, with larger effects in the mid and low technology firms. This can be explained by the fact that these kinds of firms invest substantially in upgrading their human capital to fully exploit the technological opportunities arising from foreign presence; in turn this investment effort has a great impact on their productivity growth.

The results for services/construction seem to be very similar to those for manufacturing. Nonetheless, there exist some differences mainly with regard to the interaction effect between FP and HC for the sub-sample of large technology gap firms. In this case, the corresponding estimate is negative and significant, indicating a negative association between FDI effects and the level of domestic human capital, and hence no evidence of spillovers from worker mobility. This can be explained by the fact that the amount that low technology services/construction firms spent on human capital might not be sufficient or the quality of their human capital might not be good enough to successfully exploit foreign technological opportunities; also it might be that foreign firms succeeded in keeping their employees or that worker mobility-related spillovers are regional. Other differences appear with regards to the estimated coefficients of FP and $FP * HC$ for high technology services/construction firms, which are, in this case, insignificantly negative and significantly positive, respectively. The negative effect of the FP coefficient may be the result of a reverse-spilling-over process, wherein foreign firms that is no longer competitive try to acquire the best domestic technology via demonstration. Meanwhile, the positive interaction effect denotes that besides competition-related spillovers high technology services/construction firms appear to benefit from foreign presence by investing in human capital. It is argued that the technology in the service sector is much more embedded in human capital than in machinery and equipment and so, it is expected to be highly specific to the originating firm and largely tacit in nature. Given that human capital is of extreme importance in the services/construction industry, even high technology firms might invest in recruiting, for example, top-level domestic managers of foreign affiliates, considered as important for their productivity improvement.

Columns 3 and 4 of tables 9.3, and 9.5 report the results of spillovers according to the level of the absorptive capacity in terms of learning and investment efforts for manufacturing and services/construction firms, respectively. Estimated coefficients of both FP and $FP * HC$ are positive and significant only for high-$INVEST$ sub-samples, indicating that only domestic firms which highly invest in the absorption of foreign knowledge have more efficiently internalized FDI spillovers from technology transfer;[15]

[15]This result seems consistent with Narula and Marin (2003)'s analysis.

the size of spillovers is larger for services/construction than for manufacturing.[16] The estimated coefficients of $\Delta Comp$ for high-$INVEST$ sub-samples are significantly positive for manufacturing and insignificantly negative for services/construction, suggesting that there is no evidence for competition-related spillovers. Moreover, domestic firms which invest little in the absorptive capacity are not capable of reaping profits via any of the spillover channels. Our findings confirm the importance of the investment and training efforts of domestic firms in productively absorbing foreign knowledge occurring from demonstration effects and worker mobility. Both channels require high investment levels to be able to efficiently use the best foreign technology once having introduced it into their existing technological process.

2.2. Spillovers at the regional level. Regarding the role of the regional dimension on spillover effects, columns 2, 6, 7, and 8 in tables 9.2 and 9.4 and columns 2, 5, and 6 in tables 9.3 and 9.5 report the spillover results at both the regional level and from outside the region. Compared with the regression results for the full sample of manufacturing and services/construction, wherein spillovers do not seem to occur at the industrial level, column 2 reports different results in which the coefficients of FP and $FP * HC$ become positive and significant at the regional level and remain insignificant and even significantly negative outside the region. Yet, the $\Delta Comp$ estimates remain positive and significant. Then the results confirm that spillovers seem to have a regional dimension. Domestic firms gain from the presence of foreign firms in their region, but loose out if the firms are located in different regions. This benefit seems to be only in the form of technology transfer. There is still no evidence for competition-related spillovers all the firms are taken together. The coefficients of HC and ΔLnL remain positive and significant, suggesting that the change in human capital and employment levels of domestic firms is broadly associated with productivity increase. The ΔLnK estimate remains positive and highly significant only for services/construction while $Size$ becomes positive and significant in column 2 of table 9.3, 9.4, and 9.5.

As for the three sub-samples characterized by the values for the variable GAP, the FP at the regional level "$FP_{j,r}$" remains positive and significant for all the sub-samples except for the small technology services/construction firms, with mid technology firms experiencing the larger regional demonstration-related spillover effects. In sharp contrast, the FP outside the region "$FP_{j,R-r}$" is not significant for all the sub-samples except for the mid technology manufacturing firms which appear to benefit also from outside their region – such benefit is by far smaller than that of $FP_{j,r}$. This indicates that the industrial demonstration-related spillover benefits previously reported for mid and low gap groups are mainly the outcome of regional effects.[17] Besides

[16] It is worth noting that Ben Hamida and Gugler's (2006) results of the FDI effects of 1998 on the productivity change between 1998 and 2001 were not consistent for services/construction firms.

[17] It is worthy to note that the size of regional demonstration-related spillovers do not seem to be larger than that at the industrial level.

the positive effects of $FP_{j,r}$, mid technology services/construction firms appear to succeed in reaping spillover benefits from the interaction between $FP_{j,R-r}$ and HC;[18] this implies that those firms do not benefit from outside FP unless they upgrade their human capital level – this kind of interaction does not seem to have any significantly positive effects for other groups of firms. The estimated coefficients of $FP_{j,r} * HC$ are significantly positive only for the high gap firms' sub-samples and the small gap services/construction firms, indicating that for such kinds of firms the combined effect of these variables contribute to a productivity increase. For low technology firms, the size of such an interaction effect is larger than that of $FP_{j,r}$, suggesting that the influence of regional FDI on the productivity development of these firms is broadly co-determined by the level of their human capital – this could be evidence for worker mobility-related spillovers. Low technology firms do not seem to benefit from foreign firms located outside their region, since as we have mentioned before neither $FP_{j,R-r}$ nor $FP_{j,R-r} * HC$ are significantly positive. Given that, we can conclude that the industrial spillover benefits gained through the mechanism of worker mobility are also for the most part the outcome of regional effects. Indeed, even low technology services/construction firms which seem to not benefit from worker mobility-related spillovers at industry level appear to gain a lot from these kinds of effects at regional level.

As for $\Delta Comp$, it remains negative and significant for small gap firms; mid and large gap firms do not seem to benefit from competition-related spillovers. in the opposition to the industrial level, high technology firms appear to also gain benefits from spillovers from technology transfer since $FP_{j,r}$ and $FP_{j,r} * HC$ are positive and significant – these benefits are much smaller than that of $\Delta Comp$.

In columns 5 and 6 in tables 9.3 and 9.5 we report the results of spillover effects at the regional level for the sub-samples characterized by the values for the variable $INVEST$. Only domestic firms which have highly invested in the absorption capacity gain benefits from spillovers. Such benefits are mainly regional and result from technology transfer – manufacturing firms seem to also gain spillover benefits from outside the region since $FP_{j,R-r}$ is significantly positive.[19] $\Delta Comp$ does not appear to have any positive spillover effects on the productivity increase in manufacturing and services/construction.

Finally, it is worthy to note that the Chow tests soundly support our divisions at industrial and regional levels (with respect to GAP and $INVEST$) of both manufacturing and services/construction samples.

3. Concluding comments

In part 2 we developed a theoretical model for spillovers distinguishing these effects according to their diverse channels. We recognized that domestic technological characteristics influence spillover benefits, and we argued

[18] Such benefit is also by far smaller than that of $FP_{j,r}$.

[19] Note that the benefit from outside the region is smaller than that of $FP_{j,r}$.

that the size and the extent of this benefit depend largely upon the interaction between the mechanisms by which they occur and the technological levels of domestic firms. And we assumed that regional proximity matters for spillovers.

Our theoretical hypotheses are tested against empirical evidence for Switzerland. Chapter 8 contained our analysis of interviews conducted with foreign and domestic firms operating in Switzerland, while this chapter focused on testing econometrically the effects of spillovers at industrial and regional levels according to their channels and to the level of the absorptive capability of domestic firms.

Based on samples of Swiss manufacturing and services/construction firms, we show that it is important to disentangle the spillover effects of technology transfer from that of competition increase by employing technology and competition control variables, and to distinguish between technology transfer from demonstration and that from worker mobility. Also taking into account a thorough measure of absorptive capacity, wherein the level of technological capacity of the domestic firms is associated with their investment efforts in their absorptive capability appears to be highly significant, when evaluating productivity spillovers generated from FDI.

In fact, taking all the firms together, the results do not report significant evidence for spillover benefits via any spillover channel, either for manufacturing or for services/construction. However, looking separately at three sub-samples of firms characterized by the size of the technology gap between domestic and foreign firms, yields different results. We find that domestic firms with high technological capacity appear to benefit from spillovers from FDI heightening competition, while mid technology firms benefit a lot from demonstration effects. Yet, low technology firms which are not able to benefit from foreign affiliates via demonstration effects alone, manage to reap the spillover benefits via the recruitment of the MNCs' labor that can help them to successfully imitate foreign knowledge. The regression results are found to be more consistent in manufacturing than services/construction.

Furthermore, when taking into account the investment level of domestic firms in their absorptive capacity, we find evidence for positive spillovers only in the sub-sample of firms with relatively high $INVEST$ level. This benefit results from the FDI technology transfer. Spillovers, however, negatively affect the productivity of domestic firms which do not actively engage in investment and learning to be able to absorb foreign knowledge. Our findings also demonstrate that the regional dimension matters for spillovers in Switzerland.

To sum up, our empirical findings (chapters 8 and 9) consider that FDI promotion measures should take into account that potential spillovers require a sufficient level of human capital for domestic firms, especially for mid and low gap firms, to be able to efficiently use foreign knowledge. Robinson and Schweizer (2006), looking at measures for the Swiss government to take to improve attractiveness, identify the development of training and education as well as the simplification of administrative procedures as the strongest suggestions.

Like our theoretical findings, our empirical analysis goes along with many scholars' proposals (such as Blomström and Kokko, 2001 and Meyer and Sinani, 2004) that support learning and investment in domestic firms as a necessary condition for maximizing the technological spillovers from inward FDI. And foreign firms might be established near their domestic counterparts, in particular mid and low "services/construction" technology firms, in order to better absorb foreign resources and then upgrade their technological competitiveness.

Conclusions and future research

As previously noted, the present study attempts to contribute to the literature on MNCs effects and tends to propose some components for a research agenda on intra-industry spillovers for host countries. Unlike existing studies, it calls upon a detailed analysis of these effects according to the mechanisms by which they occur (viz. demonstration effects, competition effects, and worker mobility). Relatedly, it suggests that the size and the extent of spillovers depend largely upon the interaction between the mechanisms by which they occur and the technological capacities of domestic firms. In addition, our study makes use of a thorough measure of domestic absorptive capacity in which the learning and investment efforts of domestic firms come with their existing technological capacities; an argument disregarded by existing empirical studies except Narula and Marin (2003). And, in line with Audretsch (1998) and Aitken and Harrison (1999) it argues that geographical proximity is also an important element in determining the size and the extent of spillover effects.

On the basis of these hypotheses, this study offers a more complete picture of intra-industry spillovers at both the theoretical and the empirical levels.

With regards to our theoretical contribution, we develop an evolutionary model which suggests that the effects of foreign presence on the productivity development of domestic firms in terms of spillovers is likely to vary according to a number of indicators, namely, spillover channels, local technological characteristics, and geographical proximity. In this respect, spillovers are determined by the interaction between the channels by which they occur and the technological characteristics of the recipient host firms. And geographical proximity is an important element in determining the size and the extent of spillovers. The simulation results seem to confirm the hypotheses, in which high and mid technology firms benefit a lot from, respectively, competition and demonstration effects, while low technology firms are not able to benefit from foreign affiliates via demonstration effects alone, rather they manage to reap this benefit via the recruitment of the MNCs' human capital, in that this channel provides some assistance which can help domestic firms to imitate successfully. Simulation results also show that the size and the extent of spillovers vary according to the mechanisms by which they occur; spillovers via worker mobility for example are higher than through demonstration effects. And the geographical dimension matters for spillovers in that spillover benefits are found to be more pronounced in locations where domestic firms are close to their foreign affiliates.

We test the theoretical findings outlined above against empirical evidence for Switzerland. The empirical evidence consists of, firstly, qualitative analyses of data and interviews made with managers of foreign and domestic firms established in Switzerland; and secondly, a regression analysis wherein we test the size and the extent of spillovers at both the industrial and the regional levels according to the mechanisms by which they occur, the levels of the existing technological capacity of domestic firms, and the levels of their learning and investment efforts in the absorptive capacity. The interviews and regression analyses seem to confirm our hypotheses for Switzerland. We find that domestic firms with high technological capacity benefit from spillovers from the FDI competition effects, while mid technology firms benefit a lot from demonstration effects. And low technology firms which are not able to benefit from foreign affiliates via demonstration effects alone, manage to reap the spillover benefits via the recruitment of the MNCs' labor, which can help them to successfully imitate foreign knowledge. The regression results also demonstrate that only domestic firms that largely invest in the absorptive capacity benefit from spillovers, which mostly result from the technology transfer. In addition our findings confirm that the regional dimension is an important element in assessing spillovers in Switzerland. The regression results are found to be more consistent in manufacturing than services/construction.

Thus, it is clear from our simulation and empirical findings that spillover channels, domestic technological characteristics, and geographical proximity between foreign and domestic firms determine FDI intra-industry spillover effects; and that systematic differences between domestic firms should therefore be expected. That is we find strong evidence that domestic firms, according to their existing technological capacities, do not benefit from FDI intra-industry spillovers in the same way. In addition, the ability and the motivation of domestic firms, especially mid and low gap firms, to engage in learning and investment efforts to absorb foreign technologies and skills have a great impact on spillovers. And foreign affiliates established in proximity to domestic firms, in particular mid and low "services/construction" technology firms, are better able to absorb foreign resources and then upgrade their technological competitiveness.

Inevitably this study has some limitations. Firstly, the data set available for the analysis conducted in this study does not allow for a detail examination of the MNCs' affiliates' technological characteristics (mainly the type of technology transferred abroad and the complexity level of this technology), the MNCs' motives for foreign production, and the types of foreign ownership as determinants of spillover effects since these factors are also of great importance to policy-makers in leveraging the potential benefits of inward FDI spillovers.[20] Future studies aiming at exploring these features along with domestic characteristics and spillover channels could be promising.

Secondly, since our study has concentrated on a detailed analysis of spillover effects from the MNCs' affiliates to domestic firms, the reverse

[20]These factors have been analyzed in, among others, Kokko (1994), Kokko et al. (2001), Dimelis and Louri (2002), Marin and Bell (2004), and Driffield and Love (2006a).

effects – from domestic firms to the MNCs' affiliates – have not been well examined. As already emphasized by other authors (for example, Driffield and Love 2006b, and Sanna-Randaccio and Veugelers 2007), the test for the reverse spillover effects, especially for developed economies, could also be interesting.[21] As we have noted from the analysis of interviews with managers of foreign firms (chapter 8), in some industries such as banking and insurance MNCs set up affiliates in Switzerland to be able to learn from the best Swiss technologies and hence we expect that foreign affiliates gain benefits from spillovers from Swiss-leaders.

Moreover, exploring other kinds of spillovers such as inter-industry and market access spillovers could be also of a great importance, since it is argued that on the one hand, the commercial ties between MNC's affiliates and either "upstream" domestic suppliers or "downstream" domestic customers lead to a transfer of technical and commercial information to suppliers and customers. And on the other hand, the foreign affiliates' own export operations may facilitate the entrance of domestic firms into the same markets. To test for these kinds of spillovers, additional information is needed which is not available from our data. For example, spillover effects operating across sectors requires a detailed analysis of the inter-industry relationships (input-output matrices) to identify domestic customers and suppliers – detailed information on the flow of commodities from production through intermediate use by industries and purchases by ultimate customers – so as to determine the share of foreign affiliates in the output of both upstream and downstream sectors.[22]

Finally, we suggest that it is also important for future research to analyze the effects of spillovers on the home countries of the MNCs, since there is little empirical evidence on this aspect (Veugelers et al. 2005).[23] For example, R&D is one of the most interesting production stages of a firm and MNCs prefer, under some conditions, to carry on part of their R&D activities abroad. Particularly, Swiss MNCs are increasingly investing in R&D abroad – Arvanitis and Hollenstein (2006) find that knowledge-seeking FDI is among the main motives for Swiss MNCs that conduct R&D abroad; in turn it is expected that some of the potential benefits of such investment would be to the home country. Blomström and Kokko (1998) claim that the impact on the home country is likely to depend on what activities MNCs concentrate on at home.

[21] Singh (2007), for example, finds no significant knowledge inflows from foreign MNCs to host country organisations, but significant outflows back from the host country to foreign MNCs.

[22] For empirical studies analyzing inter-industry spillovers see, among others, Javorcik (2003), Chung et al. (2003), and Giroud (2007).

[23] More details on the home country's spillover effects from FDI are given in the empirical papers of, among others, Globerman et al. (2000), Bitzer and Görg (2005), and Vahter and Masso (2006).

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Appendix 1: The eclectic paradigm of international production, Source: Dunning (1993)

Ownership-specific advantages	Internalization incentives advantages	Location specific variables
- Property right and/or intangible asset advantages: such as, product innovations, production management, organizational and marketing systems, noncodifiable knowledge, etc. - Advantages of common governance: 1) those that branch plants of establishes enterprises may enjoy over de novo firms. 2) which specifically arise because of multinationality.	- Avoidance of search and negotiating costs. - To avoid costs of moral hazard and adverse selection, and to protect reputation of internalizing firm. - Buyer uncertainty about nature and value of inputs. -When market does not permit price discrimination. - Need of seller to protect quality of intermediate or final products. - To capture economies of interdependent activities. - To compensate for absence of future markets. - To avoid or exploit government intervention. - To control supplies and conditions of sale of inputs. To control market outlets. - To be able to engage in practices (cross-subsidization, etc.) as a competitive strategy.	- Special distribution of natural and created resource endowments and markets. - Input prices, quality and productivity. - International transport and communication costs. - Investment incentives and disincentives. - Artificial barriers to trade in goods and services. - Societal and infrastructure provisions. - Cross-country ideological, language, cultural, business, political, etc. differences. - Economic of centralization of R&D production and marketing. - Economic system and policies of government.

Appendix 2: Derivation of the model of Fosfuri et al. (2001)

More formally, the Model of Fosfuri et al. is represented in a game tree (fig. 1, page 209) which consists of two periods and includes a domestic firm (d) and a multinational (f) that has some technological advantages and decides at time $t = 0$ whether to export (E) or to do FDI. When exporting, the firm makes use of production facilities and trained workers located in the home country. When investing in the host country, the MNC incurs a fixed cost G – which includes all the expenses associated with operating in an unfamiliar foreign environment – and the training cost of local worker F which is equal to zero for simplicity.

At time $t = 1$, Fosfuri et al. assume that production takes place, the goods are sold and profits are realized. The MNC is considered a monopolist (M) in the market in the first period, because the domestic firm has no access to its technology. If it exports, MNC's profit is $N_1\Pi_M^E(t)$ – t is the export cost and $N_1$the size of the market in period 1 and equals to 1. If it does FDI, the profit is $N_1\Pi_M$ with $\Pi_M > \Pi_M^E(t)$.

After production takes place, the domestic firm recognizes the possibility of gaining access to foreign technology by hiring the trained worker. The MNC tries to retain this worker to avoid the diffusion of its technology. At time $t = 1^{'}$, the MNC decides once more whether to export or do FDI, production then takes place and the second-period payoffs are realized. If the MNC succeeds in keeping the trained worker within its boundaries, its second period profit is given by $N_2\Pi_M$, while is $N_2\Pi_M^E(t)$ if it exports, where N_2 is the size of the market in period 2. Note that it is assumed that the MNC does not export in the last period of the game.

If the domestic firm succeeds in hiring the trained worker and enters the market, both firms earn profit $N_2\Pi_D(\Phi)$, where D stands for duopoly and the parameter $\Phi \in [0, 1]$ is an inverse measure of the degree of competition in the industry – $\Phi = 0$ in case of homogenous products and the price competition, while $\Phi = 1$ in case of independent markets. It is assumed that $\Pi_D(\Phi)$ is differentiable and increases with Φ – where $\Pi_D(0) = 0$ and $\Pi_D(1) = \Pi_M$.

It is argued that the domestic firm has to pay a fixed cost $k > 0$ to benefit from the technology embedded in the trained worker. This parameter is interpreted as an inverse measure of the absorptive capability of the domestic firm. If the worker receives general training, k will be very low – i.e. the technology is easily transferable. If instead he receives training in firm-specific technology, k will be very high.

Appendix 2: Derivation of the model of Fosfuri et al. (2001)

Given that the domestic firm's valuation of the trained worker is

$$v_d = N_2\Pi_D(\Phi) - k, \tag{3.1}$$

the MNC's valuation is

$$v_f = N_2(\Pi_M - \Pi_D(\Phi)). \tag{3.2}$$

Then, the firm whose valuation of trained worker is highest hires him. Thus two solutions emerge: either $v_f \geqslant v_d$, and the MNC keeps the worker by paying him $w = N_2\Pi_D(\Phi) - k$; or $v_f \leq v_d$, and the local firm hires of the trained worker by paying him $w = N_2(\Pi_M - \Pi_D(\Phi))$. In the first case, the MNC pays the local worker more than the wage in the pool, and the local economy enjoys pecuniary spillovers. In the second case, technology spillovers occur, since the local firm manages to acquire the MNC's technology embedded in the trained worker. Accordingly, technology spillovers never arise if

$$N_2(\Pi_M - 2\Pi_D(\Phi)) + k \geqslant 0. \tag{3.3}$$

Solving this game gives rise to three possible equilibrium solutions:[24]

1) FDI and Technology spillovers: The MNC invests in the first period and there exist technology spillovers if equation (3.3) does not hold true and

$$\Pi_M - \Pi_M^E(t) \geqslant N_2(\Pi_M - \Pi_D(\Phi)). \tag{3.4}$$

2) FDI and pecuniary spillovers: the MNC invests in the first period but technology spillovers do not occur if the condition embodied in equation (3.3) holds and

$$\Pi_M - \Pi_M^E(t) \geqslant N_2\Pi_D(\Phi) - k. \tag{3.5}$$

3) Exports: the MNC's exports in the first period, and no spillovers arise.

[24] As illustrated in fig.2, page 214 of Fosfuri et al. paper, these equilibrium outcomes largely depend on the degree of competition in the industry, Φ and the level of absorptive capability of domestic firm, k^{-1}. Technology spillovers are more likely to occur when both Φ and k are low.

Appendix 3: Summary of empirical studies exploring intra-industry spillovers from FDI

Appendix 3: Summary of empirical studies exploring intra-industry spillovers from FDI

Authors	Countries	Data period analyzed	Data type	Level of analysis	Proxies of spillover variables	Dependent variables	First results	Second results
Caves (1974)	Australia	1966	CS	Industry	Share in employment	Value-added/labor	+	
Globerman (1979)	Canada	1972	CS	Industry	Share in value-added	Value-added/labor	+	
Blomström & Persson (1983)	Mexico	1970	CS	Industry	Share in employment	Value-added/labor	+	
Blomström (1986)	Mexico	1970,75	CS	Industry	Share in employment	Deviations of Value-added/labor from the best industry practice	+	
Cantwell (1989)	European Countries	1955,75	CS	Industry	Change in Industry's market share	Changes in the market shares	-	+ only for industries where domestic firms had some traditional technological strength
Haddad & Harrison (1993)	Morocco	1985-89	Panel	Firm	Share in assets	1) Change in Value-added 2) Value-added/labor	n.s. -	
Kokko (1994)	Mexico	1970	CS	Industry	Share in employment	Value-added/ labor	+	+ even for industries with a large productivity gap or with complex foreign technology
Blomström and Wolff (1989)	Mexico	1965,84	CS	Industry	Share in employment	Change in output/labor Change in technology gap	+	+ in sectors where existing technology gap is greater
Kokko (1996)	Mexico	1970	CS	Industry	1) (a) Share in employment for demonstration effects And (b) foreign value-added/labor for competition effects	Value-added/ labor		+ only for samples without enclave industries

Kokko et al. (1996)	Uruguay	1990	CS	Firm	Share in total output	Value-added/ labor	n.s.	+ only for firms with a small technology gap
Sjöholm (1997)	Indonesia	1980,91	CS	Firm	The average share in total gross output between 1980 and 1991	1) Value-added/labor 2) Change in Value-added/labor	+	+ only for firms with a high degree of competition
Perez (1997)	U K	1983,89	CS	Industry	Initial (1983) technology gap	1) Change in value-added / labor 2) Change in technology gap		+ only (for high and low technology industries)
Aitken & Harrison (1999)	Venezuela	1976-89	Panel	Firm	1) Share in equity, weighted by each firm's share in industry employment 2) (a) Share in employment in the same industry and region And (b) Share in employment in same industry but outside the region	Log of total output	-	+ with regional FDI
Sjöholm (1999)	Indonesia	1980,91	CS	Firm	1) Share in industry gross output 2) Share in industry gross output within the region (province and district)	Change in value-added	+	- with regional FDI
Girma et al. (1999)	UK	1991-96	Panel	Firm	Share in total output	1) Value-added/labor (at level and growth rates)	n.s.	+ only for firms with a relatively low technology gap, operating in competitive industries

						2) total factor productivity (at level and growth rates)		
Konings (1999)	Bulgaria, Romania and Poland	1993-97	Panel	Firm	Share in output	Log output	n.s. for Bulgaria and Romania - for Poland	+ only for firms with a high level of absorptive capacity (only for Poland and Bulgaria) n.s. for Romania
Blomström and Sjöholm (1999)	Indonesia	1997	CS	Firm	1) Share in output 2) (a) Share in otput with a minority foreign ownership, And (b) Share in output with a majority foreign ownership	Value-added/labor	+	+ for both (a) and (b)
Djankov & Hoekman (2000)	Czech Republic	1992-97	Panel	Firm	Share in total assets	Change in total factor productivity	-	
Liu et al. (2000)	UK	1991-95	Panel	Industry	1) (a) Share in total physical capital stock to measure knowledge spillovers And (b) foreign value-added/labor for competition effects	Value-added/labor	+	+ and more pronounced in industries with high technological capacities and low technology gaps + for spillovers from competition effects
Yudayeva et al (2000)	Russia	1993-97	Panel	Firm	Share in output	Output/labor	+	
Barrios (2000)	Spain	1990-94	Panel	Firm	Share in value-added	Log(value-added)	n.s.	
Kinoshita (2001)	Czech Republic	1995-98	Panel	Firm	Share in employment	Value-added/labor growth	n.s.	+ only for firms which actively perform R&D
Chung (2001)	US	1987-91	Panel	Industry	1) (a) Change in percent foreign sales to measure knowledge spillovers	Change in total factor productivity	n.s.	+ competition related spillovers and knowledge spillovers only for relatively uncompetitive US industries

					And (b) Change in industry markup to measure competition-related spillovers			
Kokko et al. (2001)	Uruguay	1988	CS	Firm	Share in output	Value-added/labor		+ only with local market oriented foreign investors
Castellani and Zanfei (2001)	France, Italy and Spain	1993-97	Panel	Firm	Share in employment	Log real output	+ for Italian firms n.s. for Spanish and French firms	+ for all firms with high gaps + for firms in science based industries with low gaps and high absorptive capacities
Girma and Wakelin (2002)	UK	1988-96	Panel	Firm	1) (a) Share in employment in the same region and sector And (b) Share in employment in the same sector but outside the region	Log output		+ in the same region - outside the region
Meyer and Sinani (2002)	Estonia	1995-99	Panel	Firm	1) Share in (employment, sale or equity) 2) (a) Share in (employment, sale or equity)*labor quality for labor mobility effects, (b) Share in (employment, sale or equity) for demonstration and	Change in output	+ when spillover is measured by the share in employment and equity n.s. when the share in sale is used	+ for spillovers from competition and demonstration-vertical linkages effects - for spillovers from worker mobility

					vertical linkages effects, and (c) foreign herfindahl index for competition effects			
Haskel et al. (2002)	UK	1973-92	Panel	Firm	Share in employment	Change in real gross output	+	
Schoors and Van Der Tol (2002)	Hungaria	1997-98	Panel	Firm	Share in sales	Output/labor	+	
Flôres et al. (2002)	Portugal	1992-95	Panel	Industry	Share in value-added	Value-added/labor	n.s.	+ only for industries with an intermediate productivity gap
Barrios and Strobl (2002)	Spanish	1990-98	Panel	Firm	Share in sales	Total factor productivity	+	+ only for domestic exporters
Castellani and Zanfei (2002)	Italy	1992-97	Panel	Firm	1) Share in (employment, capital or output) 2) Levels of (employment, capital or output)	Log change in total factor productivity	-	+ with absolute variable
Buckley et al. (2002)	China	1995	CS	Industry	Share in (employment or capital)	Output/labor	+	+ for industries with collectively-owned firms
Dimelis and Louri (2002)	Greece	1997	CS	Firm	1) Share in (employment, capital or sales) 2) (a) Share in (employment, capital or sales) with a minority foreign ownership, And (b) Share in (employment, capital or sales) with a majority foreign	Log output/labor	+	+ for (a) irrespective to the spillover measure used and more pronounced for lower productivity domestic firms n.s. for (b) only in terms of foreign share in sales.

					ownership			
Narula and Marin (2003)	Argentina	1992,96	CS	Firm	Change in percent foreign employment	Log change in total assets	-	+ only for firms which have invested more in their absorptive capacities
Damijan et al. (2003)	Bulgaria, Czech Republic, Estonia, Hungary, Poland, Romania, Slovak Republic and Slovenia	1994-98	Panel	Firm	Share in (sales or export)	Change in total factor productivity	n.s.	+ only for Romanian firms which actively perform R&D
Yeaple and Keller (2003)	US	1987,96	CS	Firm	Change in percent foreign employment	Change in total factor productivity	+	+ only for relatively high technology industries
Girma (2003)	UK	1989-99	Panel	Firm	1) (a) Share in employment in the same region and sector And (b) Share in employment in the same sector but outside the region	Total factor productivity		+ only for moderately high-tech firms and when FDI is motivated by the desire to exploit some competitive advantage possessed in the UK
Buckley et al. (2003)	China	1995	CS	Industry	1) Share in (capital or employment)	Output/labor	+	+ and more pronounced when a curvilinear relationship between foreign presence and productivity spillovers is accounted for
Driffield (2004)	UK	1984-97	Panel	Industry	1) The stock of foreign capital in the industry across all regions	Log output		+ with regional FDI

					2) The stock of foreign capital in the industry and region			
Karpaty and Lundberg (2004)	Sweden	1990-00	Panel	Firm	1) Share in employment 2) (a) US Share in employment And (b) Share in employment from the rest of the world	Log total factor productivity	+	+ and more pronounced with US foreign share
Lenger and Taymaz (2004)	Turkey	1983-00	Panel	Industry	Share in employment	Log output/labor	-	
Görg and Strobl (2004)	Ghana	1991-97	Panel	Firm	1) (a) Dummy variable (1 if owner received training by multinational, 0 otherwise), (b) Dummy variable (1 if owner had gained experience working for a multinational within the same industry, 0 otherwise), And (c) Dummy variable (1 if owner had gained experience working for a multinational in a different industry, 0 otherwise)	1) Log change in total factor productivity 2) Log change in output/labor 3) Log change in value-added/labor		+ only for firms which are running by owners who had gained experience working for a multinational within the same industry
Girma and Görg (2005)	UK	1980-92	Panel	Firm	1) (a) Share in employment in the	Total factor productivity		+ with regional FDI, only for both extremely high-tech and

					same region and sector And (b) Share in employment in the same sector but outside the region			low-tech firms + with FDI outside the region, only for moderately high-tech firms
Ruane and Ugour (2005)	Ireland	1991-98	Panel	Firm	1) Share in employment 2) Levels of employment	1) Net output/labor 2) Change in net output/labor	n.s.	+ with absolute variable
Dimelis (2005)	Greece	1992,97	CS	Firm	Share in equity	Change in log of real output	n.s.	+ for domestic firms with small gaps
Barry et al. (2005)	Ireland	1990-98	Panel	Firm	Share in employment	1) Total factor productivity 2) Output/labor	n.s.	- for domestic exporters n.s. for domestic non-exporters
Halpern and Muraközy (2005)	Hungary	1996-01	Panel	Firm	1) Share in total sales in the industry 2) share in total sales in an industry within a region	Log of value-added	n.s.	n.s. even for regional spillovers
Liu and Wei (2006)	UK	1998-01	Panel	Firm	1) Share in (employment, Capital or sales) in an industry, in a region, or in an industry within a region 2) (a) OCDE Share in (employment, Capital or sales) in an industry, in a region, or in an industry within a region And (b) HMT Shares in	Log value-added/labor	n.s.	+ in the same region +in an industry within a region + only with HMT-FDI in an industry. + with OECD-FDI in a region, or in an industry within a region

					(employment, Capital or sales) in an industry, in a region, or in an industry within a region			
Driffield and Love (2006a)	UK	1984-95	Panel	Industry	Share in investment	Value-added	n.s.	+ only when FDI is motivated by the desire to exploit some competitive advantage possessed in the UK
Ben Hamida and Gugler (2006)	Switzerland	1998,01	CS	Firm	Share in sales	Change in Log value-added	n.s.	+ for domestic firms largely invested in absorptive capacity + for domestic firms with mid technology gap
Marin and Bell (2006)	Argentina	1992,96	CS	Firm	Share in employment	Change in log of value-added	n.s.	+ only with technologically active affiliates
Hale and Long (2006)	China	2001	CS	Firm	1) Share in employment in an industry within the same city 2) (a) Share in employment in an industry within the same city And (b) the share of employees with foreign experience	Log of value-added	-	+ for domestic firms with skilled labor mobility
Driffield and Love (2007)	UK	1987-97	Panel	Industry	Share in investment*binary dummy variable to control for the type of FDI motives	Log of value-added		+ only from FDI motivated by a strong technology-based ownership advantage
Buckley et al. (2007a)	China	2001	CS	Industry	1) Share in capital 2) (a) HMT shares in		+	+ for HMT-FDI only in labor-intensive industries

					capital And (b) other (Western) share in capital			+ for Western-FDI only in technology-intensive industries + for state-owned enterprises from HMT-FDI in labor-intensive industries and Western FDI in technology-intensive industries + for other domestic firms only from HMT-FDI in labor-intensive industries
Buckley et al. (2007b)	China	1997	CS	Industry	1) (a) HMT shares in capital And (b) other (Western) share in capital	Value-added/labor		+ only from HMT-FDI with a curvilinear relationship
Tian (2007)	China	1996-99	Panel	Firm	1) Share in (employment, capital or output) 2) Share in tangible assets and share in intangible assets, share in new products and share in traditional products, share in exported products and share in domestically consumed products, and share in skilled employment and share in less skilled employment	Log output	+ only for foreign capital share	+ only from foreign firms using tangible assets, producing domestically consumed products, producing traditional products, and employing unskilled workers

Notes:

i. **Data: "CS" denotes the cross-sectional data, while "Panel" denotes the use of combined cross-sectional time-series data in the respective analysis.**
ii. **Aggregation: use of either the industry or the firm level data in the analysis.**
iii. **Result: regression analysis finds a "+" positive and statistically significant, "-" negative and statistically significant and "n.s." statistically insignificant sign of spillovers for the aggregate sample.**
iv. **First result: the estimation of spillover effects using Caves's (1974) model.**
v. **Second result: the estimation of spillover effects after controlling for local and foreign characteristics, the regional dimension and/or the linearity and the measure of spillover variable.**

Appendix 4: Summary of the parameters and the initial values employed in simulation

A summary of the parameters and the values employed in the runs analyzed in the paper is presented below.

a	$= 0.01$
ρ	$= 0.1$
λ_1	$= 1.5$
μ_1 (if $N_{iD}^{imi}(t-1) < 0$)	$= 0.2$
μ_1 (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.3$
$w_{iD} = w_{iF}$	$= 0.16$
$\nu_1 = \nu_2$	$= 0$
$\upsilon_1 = \upsilon_2 = \upsilon_3$	0.1

When the industry has 6 firms: 2 foreign and 4 domestic firms, with geographical dimension is not taken into account.

λ_{0i} (if $N_{iD}^{imi}(t-1) < 0$), i= $D_1 ... D_4$	$= 0.5$	$\eta_{F1} = \eta_{F2}$	$= 0.6$
λ_{0D1} (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.62$	σ_{D1}	$= 0.04$
λ_{0D2} (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.7$	σ_{D2}	$= 0.05$
λ_{0D3} (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.77$	σ_{D3}	$= 0.07$
λ_{0D4} (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.75$	σ_{D4}	$= 0.07$
η_{D1}	$= 0.9$	λ_2	$= 0.15$
η_{D2}	$= 0.92$	λ_3	$= 0.3$
η_{D3}	$= 0.95$	λ_4	$= 0.05$
η_{D4}	$= 1$	μ_2	$= 0.33$

π_{D1}	$= 0.8$	f_{D1}	$= 0.23$
π_{D2}	$= 0.7$	f_{D2}	$= 0.18$
π_{D3}	$= 0.55$	f_{D3}	$= 0.13$
π_{D4}	$= 0.4$	f_{D4}	$= 0.10$
π_{F1}	$= 0.6$	f_{F1}	$= 0.15$
π_{F2}	$= 0.75$	f_{F2}	$= 0.20$

When the industry has 6 firms: 2 foreign and 4 domestic firms, with geographical dimension is taken into account.

Appendix 4: Summary of the parameters and the initial values employed in simulation

When $d_i \leq \iota = 1$

δ_{D1} (if $N_{iD}^{imi}(t-1) < 0$)	$= 1.832$	d_{D1}	$= 0.9$
δ_{D2} (if $N_{iD}^{imi}(t-1) < 0$)	$= 2.06$	d_{D2}	$= 0.8$
δ_{D3} (if $N_{iD}^{imi}(t-1) < 0$)	$= 1.812$	d_{D3}	$= 0.91$
δ_{D4} (if $N_{iD}^{imi}(t-1) < 0$)	$= 1.809$	d_{D4}	$= 0.91$
δ_{D1} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.559$	δ_{F1}	2.95
δ_{D2} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.537$	δ_{F2}	2.6
δ_{D3} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.30$	d_{F1}	0.794
δ_{D4} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.3$	d_{F2}	0.9

When $d_i > \iota = 1$

δ_{D1} (if $N_{iD}^{imi}(t-1) < 0$)	$= 1.832$	d_{D1}	$= 1.102$
δ_{D2} (if $N_{iD}^{imi}(t-1) < 0$)	$= 2.06$	d_{D2}	$= 1.069$
δ_{D3} (if $N_{iD}^{imi}(t-1) < 0$)	$= 1.812$	d_{D3}	$= 1.253$
δ_{D4} (if $N_{iD}^{imi}(t-1) < 0$)	$= 1.81$	d_{D4}	$= 1.27$
δ_{D1} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.559$	δ_{F1}	$= 1.95$
δ_{D2} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.537$	δ_{F2}	$= 2.12$
δ_{D3} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.30$	d_{F1}	$= 1.2$
δ_{D4} (if $N_{iD}^{imi}(t-1) > 0$)	$= 1.3$	d_{F2}	$= 1.09$

When the industry has 15 firms: 2 foreign and 13 domestic firms

λ_{0i} (if $N_{iD}^{imi}(t-1) < 0$)	$= 0.601$	η_{D1}	$= 0.913$
λ_{0D1} (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.711$	η_{D2}	$= 0.921$
λ_{0D2} (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.721$	η_i, i= $D_3 ... D_8$	$= 0.94$
λ_{0D3} (if $N_{iD}^{imi}(t-1) > 0$)	$= 0.722$	η_i, i= $D_9 ... D_{11}$	$= 0.95$
λ_{0i} (if $N_{iD}^{imi}(t-1) > 0$), i= $D_4 ... D_8$	$= 0.723$	η_{D12}	$= 0.951$
λ_{0i} (if $N_{iD}^{imi}(t-1) > 0$), i= $D_9 ... D_{13}$	$= 0.73$	η_{D13}	$= 0.968$

$\eta_{F1} = \eta_{F2}$	$= 0.65$	$\sigma_{D8} = \sigma_{D9}$	$= 0.034$
σ_{D1}	$= 0.03$	$\sigma_{D10} = \sigma_{D11}$	$= 0.036$
$\sigma_{D2} = \sigma_{D3}$	$= 0.031$	$\sigma_{D12} = \sigma_{D13}$	$= 0.04$
σ_{D4}	$= 0.0317$	λ_2	$= 0.184$
σ_{D5}	$= 0.032$	λ_3	$=0.301$
$\sigma_{D6} = \sigma_{D7}$	$= 0.033$	λ_4	$= 0.03$

$$
\begin{array}{|ll}
\pi_{D1} & = 0.82 \\
\pi_{D2} & = 0.78 \\
\pi_{D3} & = 0.75 \\
\pi_{D4} & = 0.72 \\
\pi_{D5} & = 0.71 \\
\pi_{D6} & = 0.7 \\
\pi_{D7} & = 0.69 \\
\pi_{D8} & = 0.67
\end{array}
\quad
\begin{array}{|ll}
\pi_{D9} & = 0.63 \\
\pi_{D10} & = 0.57 \\
\pi_{D11} & = 0.56 \\
\pi_{12} & = 0.55 \\
\pi_{13} & = 0.54 \\
\pi_{F1} & = 0.76 \\
\pi_{F2} & = 0.8 \\
\mu_2 & = 0.17
\end{array}
\quad
\begin{array}{|ll}
f_{D1} & = 0.079 \\
f_{D2} & = 0.076 \\
f_{D3} & = 0.074 \\
f_{D4} & = 0.073 \\
f_{D5} & = 0.072 \\
f_{D6} & = 0.071 \\
f_{D7} & = 0.069 \\
f_{D8} & = 0.068
\end{array}
$$

$$
\begin{array}{|ll}
f_{D9} & = 0.061 \\
f_{D10} & = 0.055 \\
f_{D11} & = 0.054 \\
f_{D12} & = 0.053 \\
f_{D13} & = 0.043 \\
f_{F1} & = 0.075 \\
f_{F2} & = 0.077
\end{array}
$$

Appendix 5: Further illustrations for data analysis

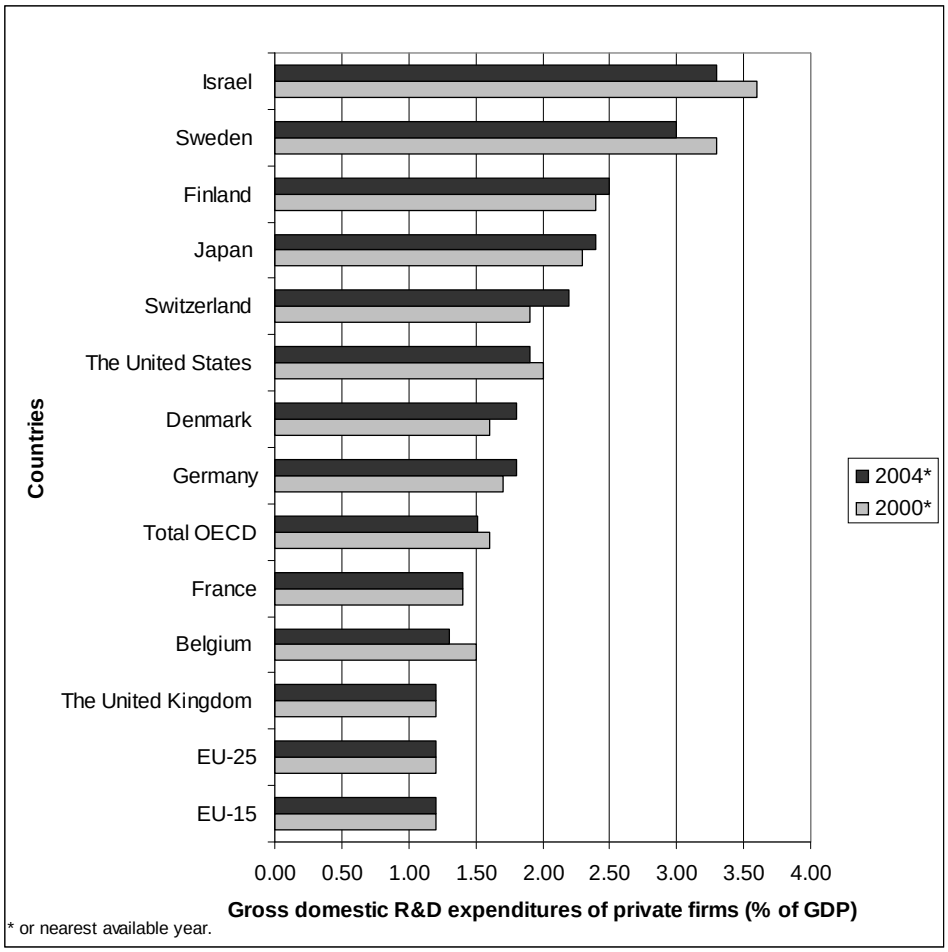

FIGURE 9.1. International comparison of gross domestic R&D expenditures of private firms (% of GDP), 2000 and 2004. Source: SFSO (2006).

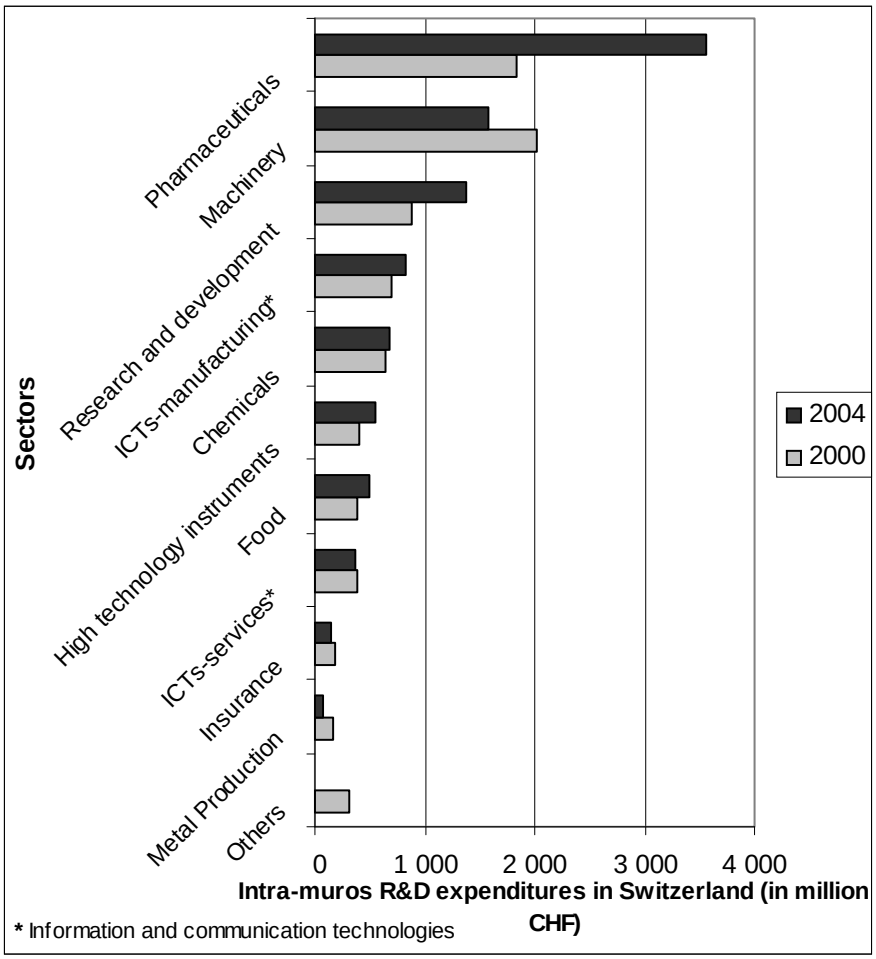

FIGURE 9.2. Intra-muros R&D expenditures in Switzerland (in million CHF, round numbers), 2000 and 2004. Source: SFSO (2006).

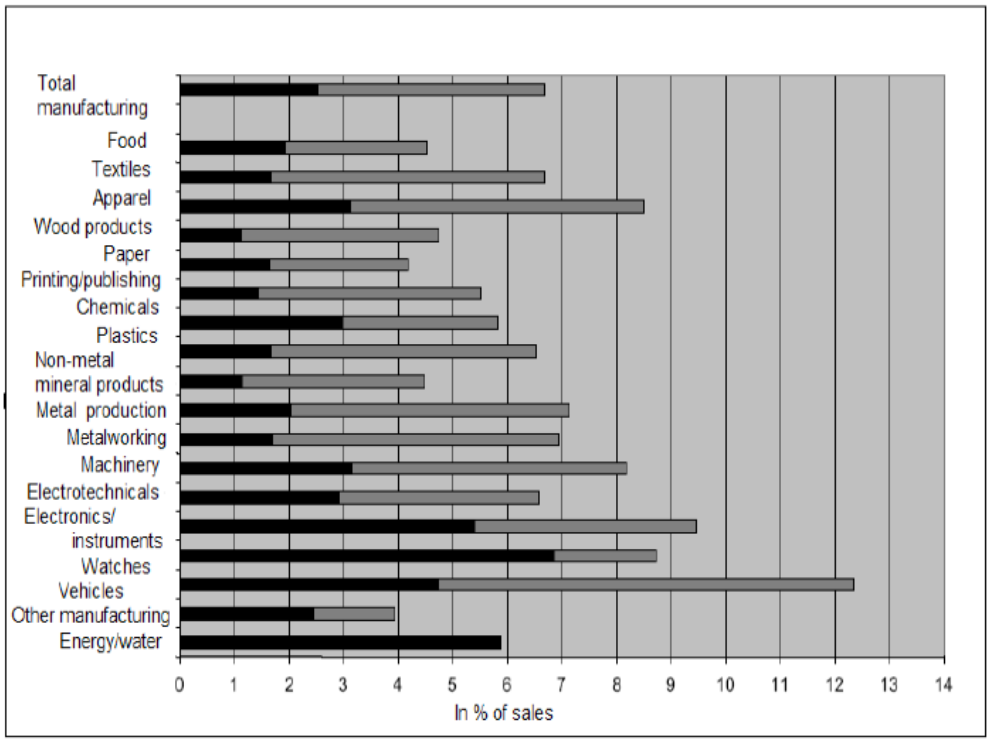

FIGURE 9.3. Accumulated amounts of innovation expenditures in Switzerland for manufacturing, 2000-2002 (wherein the Balck parts in bars denote the share of R&D expenditure). *Source*: Arvanitis et al. (2004).

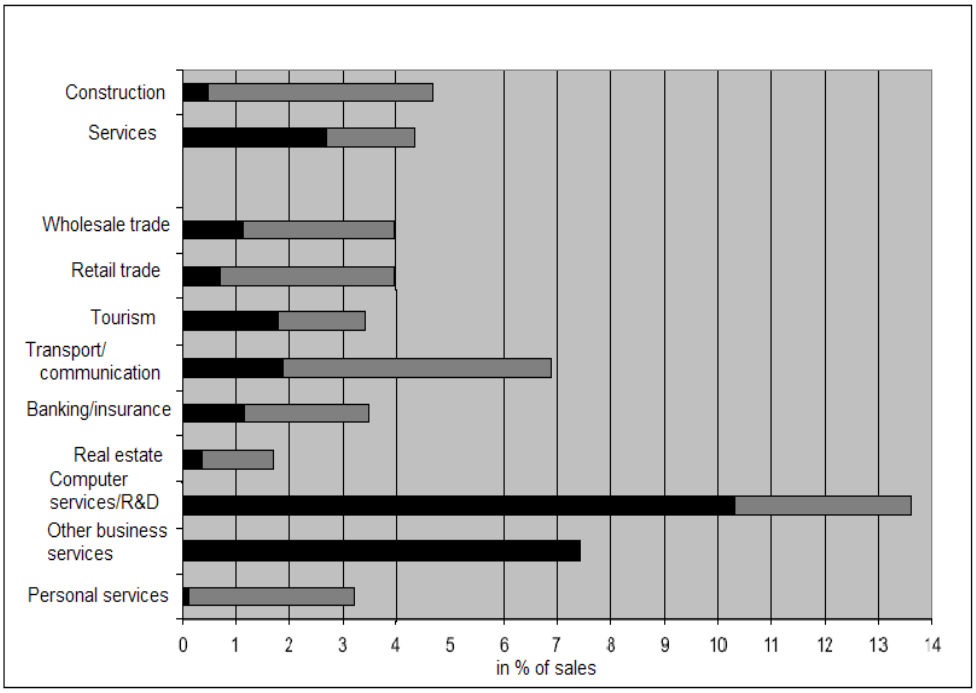

FIGURE 9.4. Accumulated amounts of innovation expenditures in Switzerland for construction/services, 2000-2002 (wherein the Balck parts in bars denote the share of R&D expenditure). *Source*: Arvanitis et al. (2004).

Appendix 6: Models of letters sent to foreign and domestic firms

Box 3. *A model of the letter sent to Swiss firms*

Mr.

University of Fribourg
Bd de Pérolles 90,
CH - 1700 Fribourg.

Neuchâtel, April 13, 2006.

Concern: Research project at the University of Fribourg on firms in Switzerland.

Dear Sir,

The University of Fribourg is currently undertaking, in the context of a PhD project, **a study of the importance of inward direct investment for the economic performance of Switzerland.**

The object of this study is to explore the role of foreign affiliates established in Switzerland for the economic development of our firms so as to gain more profits: do our firms benefit from the foreign presence in their industry, through which channels do these benefits occur, does the presence of foreign firms nearby increases their benefits, etc. For this study, we invite **120 people from firms across Switzerland that have been randomly selected** for interviews so as to discuss the strategies of their firms vis-à-vis the foreign rivals.

You may receive within the next days a phone call from Mrs Lamia Ben Hamida asking you for an interview at a time that suits you both. This interview lasts approximately 15 minutes and can be carried out by phone, within your company, or in a place that you choose. Of course, the information given is anonymous and confidential; this research does not have **any commercial or administrative goal**. We hope sincerely that you agree to take part in this study.

Thank you for your precious collaboration and with best regards.

The researchers in charge for the study
Lamia Ben Hamida*

*Lamia Ben Hamida is a PhD student in economics at the University of Fribourg. Email: lamia.benhamida@unifr.ch - www.unifr.ch. Phone 032 721 3725. Mobile 078 647 5433.

Appendix 6: Models of letters sent to foreign and domestic firms

Box 4. *Model of the letter sent to foreign affiliates in Switzerland*

Mr.

University of Fribourg
Bd de Pérolles 90,
CH - 1700 Fribourg.

Neuchâtel, April 13, 2006.

Concern: Research project at the University of Fribourg on firms in Switzerland.

Dear Sir,

The University of Fribourg is currently undertaking, in the context of a PhD project, **a study of inward foreign direct investment in Switzerland.**

The object of this study is to explore the Swiss contribution in the economic development of our foreign multinationals established within our country so as to gain more profits: why do our foreign firms choose Switzerland, do they benefit from their presence in our regions, through which channels do these benefite occur, does the presence of Swiss firms nearby increases their benefits, etc. For this study, we invite **120 people from firms across Switzerland that have been randomly selected** for interviews so as to discuss the strategies of their firms vis-à-vis the establishment in Switzerland.

You may receive within the next days a phone call from Mrs Lamia Ben Hamida asking you for an interview at a time that suits you both. This interview lasts approximately 15 minutes and can be carried out by phone, within your company, or in a place that you choose. Of course, the information given is anonymous and confidential; this research does not have **any commercial or administrative goal**. We sincerely hope that you agree to take part in this study.

Thank you for your precious collaboration and with best regards.

The researchers in charge for the study
Lamia Ben Hamida*

*Lamia Ben Hamida is a PhD student in economics at the University of Fribourg. Email : lamia.benhamida@unifr.ch - www.unifr.ch. Phone 032 721 3725. Mobile 078 647 5433.

Appendix 7: The econometric model

The equation (1.1) is derived from a Cobb-Douglas production function with value-added Y a function of two inputs, capital and labor

$$Y_{i,j,t} = A_{i,j,t} L_{i,j,t}^{\alpha 1} K_{i,j,t}^{\alpha 2}. \tag{3.6}$$

The level of productivity is given by $A_{i,j,t}$, which is assumed to vary across firms within each sector j and across time t.

After taking logarithms of the variables to get into a linear form equation (3.6) and adding a stochastic disturbance term $u_{i,j,t}$ to account for variations in the productive capabilities of the i-th firm, we can rewrite equation (3.6) for $t-3$ =2001 and t =2004 as

$$LnY_{i,j,t} = a_{i,j,t} + \alpha_1 LnL_{i,j,t} + \alpha_2 LnK_{i,j,t} + u_{i,j,t}, \ (a_{i,j,t} = LnA_{i,j,t}), \tag{3.7}$$

$$\begin{aligned} LnY_{i,j,t-3} &= a_{i,j,t-3} + \alpha_1 LnL_{i,j,t-3} + \alpha_2 LnK_{i,j,t-3} + u_{i,j,t-3}, \\ (a_{i,j,t-3} &= LnA_{i,j,t-3}). \end{aligned} \tag{3.8}$$

Then, taking the difference (3.7-3.8) yields the change in value-added for domestic firms between 2004 and 2001. Δ denotes the variation between 2004 and 2001

$$\Delta LnY_{i,j} = \Delta a_{i,j} + \alpha_1 \Delta LnL_{i,j} + \alpha_2 \Delta LnK_{i,j} + \varepsilon_{i,j,}. \tag{3.9}$$

We test the hypothesis that the productivity growth is affected by the share of foreign presence at the industry level, its interaction with the human capital of the i-th firm, and the increase in the level of industry competition, by modeling the change in a as

$$\begin{aligned} \Delta a_{i,j} &= \alpha_3 FP_{j,t-3} + \alpha_4 HC_{i,j,t} + \alpha_5 FP_{j,t-3} * HC_{i,j,t} + \alpha_6 \Delta Comp_j \\ &\quad + \alpha_7 \mathrm{Si}\, ze_{i,j,t} + \alpha_8 Age_{i,j,t} + \alpha_9 Industry_{i,j}, \end{aligned} \tag{3.10}$$

where, the change in a is also assumed to vary across sectors, the human capital of the domestic firm, and its size.

Finally, combining equations (3.9) and (3.10) yields equation (1.1) in section 1 of chapter 9.

Appendix 8: Regression results

TABLE 9.2. Estimation results for manufacturing: Spillovers from FDI and existing level of technology gap between foreign and domestic firms

	1	2	3	4	5	6	7	8
Variables	Full	Full	Small *GAP*	Mid *GAP*	Large *GAP*	Small *GAP*	Mid *GAP*	Large *GAP*
ΔLnK	-0.0004	-0.001	0.45***	-0.005	-0.006	0.43***	-0.006	0.19***
	(0.004)	(0.004)	(0.04)	(0.006)	(0.005)	(0.04)	(0.004)	(0.04)
ΔLnL	0.77***	0.86***	0.38***	0.71***	0.79***	0.38***	0.9***	0.66***
	(0.07)	(0.07)	(0.1)	(0.09)	(0.05)	(0.07)	(0.09)	(0.008)
HC	0.42***	0.47***	0.23***	0.57***	0.66***	0.44***	0.54***	0.77***
	(0.06)	(0.07)	(0.07)	(0.1)	(0.07)	(0.1)	(0.1)	(0.12)
FP_j	0.0002		0.0005	0.009***	0.005***			
	(0.0009)		(0.001)	(0.002)	(0.001)			
$FP_{j,r}$		0.001*				0.002*	0.003**	0.001*
		(0.0006)				(0.001)	(0.001)	(0.001)
$FP_{j,R-r}$		0.0003				0.00008	0.0019*	0.0008
		(0.0004)				(0.0003)	(0.001)	(0.0005)
$FP_j{*}HC$	0.006		-0.00007	0.01*	0.011***			
	(0.004)		0.003	(0.006)	(0.003)			
$FP_{j,r}{*}HC$		0.006*				0.002	-0.002	0.009***
		(0.003)				(0.004)	(0.005)	(0.003)
$FP_{j,R-r}{*}HC$		-0.002**				-0.004**	-0.002	0.0008
		(0.0009)				(0.001)	(0.002)	(0.001)
$\Delta Comp$	1.54***	1.52***	-0.36*	1.76***	1.43***	-0.289*	1.52***	0.29
	(0.14)	(0.1)	0.19	(0.15)	(0.1)	(0.17)	(0.1)	0.29
$Size$	-0.001	-0.002	0.03***	0.01	-0.007	0.01	-0.001	-0.01
	(0.008)	(0.009)	(0.01)	(0.01)	(0.01)	(0.009)	(0.01)	(0.01)
$\bar{R}^2$	0.67	0.7	0.88	0.69	0.77	0.9	0.67	0.79
$F-Chow$				15.6			9.73	
N	370	269	71	106	193	61	93	115

Note: All estimations include industry dummies. All standard errors, in parentheses, are corrected for heteroskedasticiy.
Variables (HC and FP) used for interactions are centered by subtracting the full sample means, so that (1) multicollinearity between the variables and their product is reduced, (2) better estimates of (HC and FP) are ensured, and (3) more meaningful interpretations of those estimates are granted (Aiken and West, 1991).
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

TABLE 9.3. Estimation results for manufacturing: Spillovers from FDI and the domestic absorptive capacity with respect to learning and investment

	1	2	3	4	5	6
Variables	Full	Full	High $INVEST$	Small $INVEST$	High $INVEST$	Small $INVEST$
ΔLnK	-0.002	-0.006***	0.002	-0.006	-0.002***	-0.01
	(0.003)	(0.0006)	(0.005)	(0.01)	(0.0006)	(0.009)
ΔLnL	0.85***	1.07***	0.95***	0.67***	1.12***	0.79***
	(0.08)	(0.02)	(0.07)	(0.1)	(0.02)	(0.1)
HC	0.41***	0.50***	0.41***	0.37	0.51***	0.14
	(0.07)	(0.02)	(0.08)	(0.2)	(0.02)	(0.1)
FP_j	0.0007		0.004***	-0.002		
	(0.0008)		(0.001)	(0.006)		
$FP_{j,r}$		0.001***			0.004***	-0.0004
		(0.0001)			(0.0004)	(0.001)
$FP_{j,R-r}$		-0.0002***			0.002***	-0.0006
		(0.00006)			(0.0003)	(0.0004)
$FP_j{*}HC$	0.002		0.005*	0.004		
	(0.003)		(0.003)	(0.02)		
$FP_{j,r}{*}HC$		0.003***			0.003***	-0.014
		(0.0008)			(0.001)	(0.01)
$FP_{j,R-r}{*}HC$		-0.002***			-0.003***	-0.004***
		(0.0002)			(0.0002)	(0.001)
$\Delta Comp$	1.69***	1.79***	1.67***	1.45***	1.8***	1.47***
	(0.1)	(0.02)	(0.1)	(0.2)	(0.04)	(0.1)
$Size$	0.0005	0.007***	0.004	-0.02	0.001	0.001
	(0.009)	(0.002)	(0.01)	(0.03)	(0.003)	(0.01)
$\bar{R}^2$	0.73	0.79	0.79	0.6	0.79	0.78
$F-Chow$			8.16		6.29	
N	240	182	179	61	120	62

Note: All estimations include industry dummies. All standard errors, in parentheses, are corrected for heteroskedasticiy.
Variables (HC and FP) used for interactions are centered by subtracting the full sample means, so that (1) multicollinearity between the variables and their product is reduced, (2) better estimates of (HC and FP) are ensured, and (3) more meaningful interpretations of those estimates are granted (Aiken and West, 1991).
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

TABLE 9.4. Estimation results for services/construction: Spillovers from FDI and existing level of technology gap between foreign and domestic firms

	1	2	3	4	5	6	7	8
Variables	Full	Full	Small *GAP*	Mid *GAP*	Large *GAP*	Small *GAP*	Mid *GAP*	Large *GAP*
ΔLnK	0.01***	0.01***	0.47***	0.19***	0.009***	0.53***	0.36***	0.01***
	(0.004)	(0.004)	(0.03)	(0.01)	(0.001)	(0.05)	(0.05)	(0.002)
ΔLnL	0.5***	0.69***	0.4***	0.6***	0.76***	0.35***	0.64***	0.72***
	(0.05)	(0.03)	(0.04)	(0.01)	(0.04)	(0.05)	(0.05)	(0.05)
HC	0.09***	0.38***	0.03***	0.35***	0.57***	0.38***	0.41***	0.42***
	(0.02)	(0.03)	(0.01)	(0.03)	(0.04)	(0.1)	(0.09)	(0.05)
FP_j	-0.01***		-0.0004	0.006***	0.004***			
	(0.004)		(0.0004)	(0.001)	(0.001)			
$FP_{j,r}$		0.001***				0.0009	0.006***	0.002**
		(0.0003)				(0.001)	(0.001)	(0.0003)
$FP_{j,R-r}$		-0.0005***				0.0002	0.0002	-0.0005
		(0.0001)				(0.0004)	(0.0006)	(0.0002)
$FP_j{*}HC$	0.0006		0.003*	0.009***	-0.01***			
	(0.001)		(0.001)	(0.002)	(0.002)			
$FP_{j,r}{*}HC$		0.004***				0.017*	0.004	0.0035**
		(0.001)				(0.009)	(0.005)	(0.001)
$FP_{j,R-r}{*}HC$		-0.001***				-0.002	0.004***	-0.0033***
		(0.0004)				(0.001)	(0.001)	(0.0004)
$\Delta Comp$	0.99***	1.06***	-0.35***	0.15***	1.22***	-0.4***	-0.46	0.86***
	(0.1)	(0.08)	(0.1)	(0.04)	(0.09)	(0.1)	(0.2)	(0.1)
$Size$	0.02***	0.02***	0.01**	0.0008	0.01**	0.001	0.038**	0.008
	(0.008)	(0.004)	(0.009)	(0.001)	(0.006)	(0.02)	(0.01)	(0.005)
$\bar{R}^2$	0.49	0.59	0.91	0.88	0.56	0.96	0.96	0.45
$F-Chow$				5.85			8.41	
N	287	226	66	94	127	28	64	134

Note: All estimations include industry dummies. All standard errors, in parentheses, are corrected for heteroskedasticiy.
Variables (HC and FP) used for interactions are centered by subtracting the full sample means, so that (1) multicollinearity between the variables and their product is reduced, (2) better estimates of (HC and FP) are ensured, and (3) more meaningful interpretations of those estimates are granted (Aiken and West, 1991).
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

TABLE 9.5. Estimation results for services/construction: Spillovers from FDI and the domestic absorptive capacity with respect to learning and investment

	1	2	3	4	5	6
Variables	Full	Full	High $INVEST$	Small $INVEST$	High $INVEST$	Small $INVEST$
ΔLnK	0.33***	0.3***	0.37***	0.24**	0.36***	0.47***
	(0.04)	(0.04)	(0.04)	(0.09)	(0.05)	(0.1)
ΔLnL	0.47***	0.42***	0.42***	0.63***	0.54***	0.29**
	(0.05)	(0.05)	(0.07)	(0.1)	(0.1)	(0.1)
HC	0.3***	0.2***	0.33***	0.28*	0.29***	0.009
	(0.05)	(0.05)	(0.06)	(0.1)	(0.07)	(0.09)
FP_j	0.001		0.005*	-0.002		
	(0.002)		(0.003)	(0.003)		
$FP_{j,r}$		0.003**			0.003***	0.002
		(0.001)			(0.001)	(0.002)
$FP_{j,R-r}$		0.0006			-0.0007	0.0003
		(0.0006)			(0.0005)	(0.0004)
$FP_j{*}HC$	0.001		0.012***	-0.009		
	(0.003)		(0.005)	(0.01)		
$FP_{j,r}{*}HC$		0.0019			0.006*	-0.003
		(0.002)			(0.003)	(0.004)
$FP_{j,R-r}{*}HC$		-0.0005			0.001	0.0006
		(0.0008)			(0.001)	(0.001)
$\Delta Comp$	-0.14	-0.16	-0.34	0.71	-0.24	-0.29
	(0.2)	(0.2)	(0.2)	(0.5)	(0.2)	(0.4)
$Size$	-0.007	0.02*	-0.007	-0.07	0.02	-0.02
	(0.01)	(0.01)	(0.01)	(0.04)	(0.01)	(0.03)
$\bar{R}^2$	0.74	0.71	0.72	0.81	0.72	0.88
$F-Chow$			3.25		6.6	
N	104	86	72	32	52	34

Note: All estimations include industry dummies. All standard errors, in parentheses, are corrected for heteroskedasticiy.
Variables (HC and FP) used for interactions are centered by subtracting the full sample means, so that (1) multicollinearity between the variables and their product is reduced, (2) better estimates of (HC and FP) are ensured, and (3) more meaningful interpretations of these estimates are granted (Aiken and West, 1991).
*, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.